ASSESSMENT OF
WOOD - HEATING OPPORTUNITIES
FORT SMITH, N.W.T.

Including a general design and economic analysis
for a school district wood boiler facility

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ASSESSMENT OF WOOD-HEATING OPPORTUNITIES

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Including a general design and economic analysis
for a school district wood boiler facility

Prepared for:

Fitz-Smith Native Development Corporation Ltd.
Fort Smith, N.W.T.

Prepared by:

Manecon Limited

With a contribution from:

Remote Community Demonstration Program
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TABLE OF CONTENTS

Page

ABSTRACT x

EXECUTIVE SUMMARY, Part 1 xi

EXECUTIVE SUMMARY, Part 2 xv

RESUME xvii

PART 1 - WOOD HEATING OPPORTUNITIES IN COMMERCIAL BUILDINGS

1.0 **INTRODUCTION** 1

2.0 **CANDIDATE BUILDINGS** 4

2.1 General 4
2.2 Planned New Federal Building 7
2.3 RCMP Detachment Office 9
2.4 GNWT Regional Headquarters Building 12
2.5 Winerack Building 15
2.6 Pelican Rapids Inn 18
2.7 Pinecrest Hotel 22
2.8 Hudson's Bay Store 25
2.9 Fort Smith Airport Facilities 29

3.0 **OWNER INTEREST, ATTITUDES AND CONSTRAINTS APPLIED TO WOOD HEATING** 37

3.1 General 37
3.2 Perceived Owner Attitudes 39

3.2.1 Proposed New Federal Building 39
3.2.2 RCMP Detachment Office 41
3.2.3 GNWT Regional Headquarters Building 42
3.2.4 Winerack Building 44
3.2.5 Pelican Rapids Inn 45
3.2.6 Pinecrest Hotel 45
3.2.7 Hudson's Bay Store 46
3.2.8 Airport Buildings 47

4.0 **WOOD HEATING SYSTEM EQUIPMENT** 49

TABLE OF CONTENTS (continued) Page

5.0 BOILER SYSTEM COSTS AND ECONOMIC VIABILITY 70

5.1 General 70
5.2 New Federal Building 73
5.3 RCMP Detachment Office 81
5.4 GNWT Regional Headquarters Building 87
5.5 Winerack Building 94
5.6 Pelican Rapids Inn 99
5.7 Pinecrest Hotel 105
5.8 Hudson's Bay Store 110
5.9 Ministry of Transport Airport Buildings 116

5.9.1 T52 Maintenance Garage 116
5.9.2 T83 Terminal Building 123
5.9.3 T35 Flight Service Centre and T83 Terminal Building 127

6.0 TOWN CORE CENTRAL WOOD BOILER FACILITY 132

6.1 Concept Description 132
6.2 Capital Costs 153
6.3 Operations and Maintenance Costs 163
6.4 Economic Viability 165

7.0 CONCLUSIONS AND RECOMMENDATIONS 170

8.0 IMPLEMENTATION PLAN 175

REFERENCES 178

LIST OF TABLES

		Page
Table ES/1	Viability of Commercial Wood Boiler Systems in Fort Smith	xiv
Table 2.4/1	Fuel Consumption - GNWT Regional Headquarters Building - Fiscal Year 1983/84	14
Table 2.6/1	Fuel Oil Consumption - Pelican Rapids Inn - Fiscal Year 1983/84	21
Table 2.7/1	Fuel Consumption - Pine Crest Hotel - Fiscal Year 1983/84	24
Table 2.8/1	Fuel Oil & Electrical Energy Consumption - Hudson's Bay Food Store - Fiscal Year 1983/84	27
Table 2.8/2	Fuel Oil & Electrical Energy Consumption - Hudson's Bay Store Fiscal Year 1983/84	28
Table 2.9/1	Fuel Oil Consumption - Department of Transport Fort Smith Airport Facilities	36
Table 5.2/1	Capital Costs - Federal Building Wood Boiler Installation	76
Table 5.2/2	Estimated Incremental Operating and Maintenance Costs for Federal Building Wood Boiler Installation	77
Table 5.3/1	Capital Costs - RCMP Detachment Wood Boiler Installation	83
Table 5.3/2	Estimated Incremental Operating and Maintenance Costs for RCMP Detachment Wood Boiler Installation	85
Table 5.4/1	Capital Costs - GNWT Regional Headquarters Building Wood Boiler Installation	89
Table 5.4/2	Estimated Incremental Operating and Maintenance Costs for GNWT Regional Headquarters Building Wood Boiler Installation	91

LIST OF TABLES (Continued)

		Page
Table 5.5/1	Capital Costs - Winerack Building Wood Boiler Installation	95
Table 5.5/2	Estimated Incremental Operating and Maintenance Costs for Winerack Building	97
Table 5.6/1	Capital Costs - Pelican Rapids Inn Wood Boiler Installation	100
Table 5.6/2	Estimated Incremental Operating and Maintenance Costs for Pelican Rapids Inn	102
Table 5.7/1	Capital Costs - Pinecrest Hotel Wood Boiler Installation	106
Table 5.7/2	Estimated Incremental Operating and Maintenance Costs for Pinecrest Hotel	107
Table 5.8/1	Capital Costs - Hudson Bay Store Wood Boiler Installation	112
Table 5.8/2	Estimated Incremental Operating and Maintenance Costs for Hudson Bay Store	113
Table 5.9/1	Capital Costs - MOT Maintenance Garage Wood Boiler Installation	118
Table 5.9/2	Estimated Incremental Operating and Maintenance Costs for MOT Maintenance Garage	120
Table 5.9/3	Capital Costs - MOT Terminal Building Wood Boiler Installation	124
Table 5.9/4	Estimated Incremental Operating and Maintenance Costs for the MOT T83 Terminal Building	125
Table 5.9/5	Capital Costs - MOT Terminal and Flight Service Station Wood Boiler Installation	128

LIST OF TABLES (continued)

		Page
Table 5.9/6	Estimated Incremental Operating and Maintenance Costs for the MOT Terminal and Flight Service Centre	129
Table 6.2/1	Estimated Capital Costs - Town Core Central Wood Boiler Facility & Distribution System	159
Table 6.3/1	Annual Operations and Maintenance Costs - Town Core Wood Boiler Heating Plant	164

LIST OF FIGURES

Figure 2.1/1(a)	Portion of Town Map Town of Fort Smith, NWT Scale: 1" = 400' approx.	5
Figure 2.1/1(b)	Town of Fort Smith Property Designations	6
Figure 2.9/1	Location of Fort Smith Airport	31
Figure 2.9/2	Airport Base Plan Scale 1" = 200' Exerpt from MOT Dwg W-134-1	32
Figure 5.2/1	Sketch of Modified Flow Circuit to Incorporate Wood Boiler	74
Figure 5.3/1	Conversion of Hot Air Furnace System to Accept Heat From External Hot Water Source	82
Figure 5.4/1	Sketch of Wood Boiler Addition to GNWT Regional Headquarters Building	88
Figure 6.1/1	Town Core Wood Boiler Plant Site Plan	133
Figure 6.2/1	GNWT Headquarters Building Central Wood Boiler Plant Tie-In	156

TABLE OF CONTENTS

Page

PART 2 - SCHOOL DISTRICT WOOD BOILER FACILITY

1.0 INTRODUCTION 179

2.0 BOILER FACILITY DESCRIPTION 181

2.1 Overview 181
2.2 Boiler Package Selection 183
2.3 Boiler Equipment Description 184
2.4 Distribution System Description 201

3.0 WOOD HANDLING SCENARIOS 213

3.1 General 213
3.2 Analysis of Alternatives 215

4.0 CAPITAL COSTS 225

5.0 ECONOMIC VIABILITY ANALYSIS 229

5.1 Present Buildings Operations Costs 229
5.2 Estimated Central Wood Boiler System Operating And Maintenance Costs 232
5.3 Project Economic Viability 234

6.0 CONCLUSIONS AND RECOMMENDATIONS 240

7.0 FOLLOW-UP ACTIVITY PLAN 242

REFERENCES 245

APPENDICES

Appendix A Boiler Facilities, Draft Call for Proposals 246
Appendix B Technical Specifications for Steam Distribution System 252
Appendix C Mechanical Drawings of the Steam Distribution System and Building Tie-ins 319

TABLES

Page

Table 3.2/1 Wood Fuel Supply Alternatives 220

Table 3.2/2 Wood Collection Costs - Options 1 & 2 221

Table 3.2/3 Wood Collection Costs - Options 3 to 8 223

Table 4.0/1 Fort Smith School District Wood Boiler System Capital Costs 226

Table 5.1/1 Building Annual Operating Costs 230

Table 5.2/1 Wood Boiler Annual Operating and Maintenance Costs 233

Table 5.3/1 Economic Viability of Partial Project Options 236

FIGURES

Figure 2.1/1 Fort Smith Wood Boiler Facility Site Plan 182

ABSTRACT

Part 1

The technical and economic feasibility of the retrofit installation of wood-fired boiler systems in selected commercial buildings in Fort Smith, N.W.T. including MOT airport facilities, is assessed. The feasibility of a single, wood-fuelled, low pressure steam boiler plant, located in the downtown core, and serving these major commercial buildings through an underground steam distribution system is assessed. Capital costs, and operating and maintenance costs for the various applications are estimated. The downtown core central wood boiler plant project is judged to be non-viable, except with significant financial grant assistance. Individual building wood boiler system retrofit installations are economically viable and technically feasible in a variety of cases.

Part 2

A central wood-fired heating system is proposed to heat a number of school buildings in Fort Smith, N.W.T. This study extends previous technical and economic feasibility studies concerning the concept in Fort Smith. A design for an underground insulated pipeline steam energy distribution system is developed and a technical specification for the materials and construction of the distribution system is assembled. The concept of heat energy sales is folded into the design, since the intention is for a private firm, the Fitz-Smith Native Development Corporation Ltd., to erect the heating facility and sell heat to the Government of the N.W.T.

The capital costs to construct the facility, the expected operating costs, and the estimated cost savings of the wood boiler operation, replacing conventional oil-fired boilers, are assembled. The proposed central wood-fired boiler heating system was concluded to be economically and technically viable in this application.

EXECUTIVE SUMMARY

Part I

The technical and economic feasibility of the installation of wood burning heating systems to serve selected commercial and government buildings in Fort Smith, is assessed in this project. The buildings include the planned new federal building, the RCMP detachment office, the GNWT regional headequarters building, the Winerack Building, the Pelican Rapids Inn motel, the Pinecrest Hotel, and the Hudson's Bay Store. These buildings are located in close proximity in the downtown core of Fort Smith and lie within a 125 m radius of the new federal building site. The MOT airport terminal building, flight service centre and the maintenance garage at the airport are also considered. The assessment considered the installation of individual, building-dedicated, wood fired hot water boiler systems. The concept of a single, centrally located wood fired low pressure steam boiler plant, serving all of the downtown core buildings heated above is also assessed. The concept proposed the delivery of steam to each client building through an underground flow line distribution system.

An examination of the building's current heating systems generally indicated that equipment is in reasonably good condition with no units imminently in need of replacement. All systems can be modified to accommodate steam energy from a remote central boiler plant, or hot water energy from a neighbouring wood boiler. All existing heating equipment is assumed to be retained for back-up or stand-by service. All buildings are currently heated by light fuel oil fired hot water boilers or hot air furnaces, except for the Winerack Building, now heated by electrical hot water boilers.

The owners were generally receptive to the notion of purchasing steam heat energy generated from a remote source, operated by a private entrepreneur. Reactions were negative, to mixed, regarding the purchase and operation of wood boiler units on their own.

The results of the economic assessment for individual building wood boilers are summarized in Table ES/1. The table indicates current heating costs; the equivalent number of air dried cords of wood fuel to meet the heating need; the capital costs required to install an appropriate wood boiler facility; the incremental cost savings realizable due to using wood fuel; and viability indicators. Payback period indicates the number of years of annual cost savings required to recover the original investment recognizing no time value for money. A discounted net present value calculation was used to provide a time-value-of-money weighted indication of project viability. The present value of annual cost savings, discounted at 7%, and net of the original capital project cost, for a 20 year project life time is indicated. On this basis, only the Pinecrest Hotel project and perhaps the federal building project are considered possibly viable. Effectiveness ratio provides a ranking of projects attractiveness adjusting NPV based on the required initial capital cost outlay. The highest ranked projects are the most effective use of investment funds.

The town core central wood boiler plant and distribution system, serving buildings #1 through #7 (Table ES/1) is estimated to cost $779,000. If energy is sold to consumers to just equal their current fuel costs, and the plant is staffed by two operators, the facility cannot generate enough revenue to meet its annual operating costs. If the labour and administrative costs can be significantly reduced by combining this operation with other proposed central wood boiler projects, a small profit on operations could be made, permitting a simple payback on initial capital investment in 14.7 years.

It is recommended that the Fitz-Smith Native Development Corporation (F/S NDC) does not proceed with the town core wood heating system unless the operation can be combined with another project as described, and non-refundable capital grants in excess of $450,000 can be secured. A secondary suggestion is made that the F/S NDC join forces with a reputable boiler systems vendor to promote the sale of individual wood boiler heating systems to the owners of the buildings where viability is indicated here. In this fashion, local contracting revenue and fuel wood supply revenue opportunities are created for the F/S NDC.

TABLE ES/1 VIABILITY OF COMMERCIAL WOOD BOILER SYSTEMS IN FORT SMITH

Building	(1) Current Heating Cost/ Annum	(2) Wood Fuel Reqt. (cords/ annum)	(3) Wood System Capital Cost	(4) Annual Operating Cost Savings	(5) Payback Period (3)/(4) (yrs.)	(6) Net * Present Value of Savings	(7) Effectiveness * Ratio (6)/(3)
1. Planned New Federal Building	$21,052	85	$98,050	$13,738	7.1	$ 47,490	.48
2. RCMP Detachment Office	8,233	33	94,500	4,495	21.0	-46,880	nil
3. GNWT Regional H/Q Building	24,460	99	113,700	16,236	7.0	58,304	.513
4. Winerack Building	15,000	42	102,400	10,606	9.6	9,960	.097
5. Pelican Rapids Inn	18,466	75	116,300	11,870	9.8	9,451	.081
6. Pinecrest Hotel	43,710	177	85,180	30,226	2.8	235,034	2.76
7. Hudson's Bay Store	19,999	81	129,300	5,486	23.6	-71,181	nil
8. MOT Maintenance Garage	11,369	46	97,100	6,700	14.5	-26,120	nil
9. MOT Terminal	6,400	26	89,770	3,107	28.9	-56,854	nil

*See Section 5.1 for assumptions

EXECUTIVE SUMMARY

Part 2

This project provides a technical description and economic viability analysis for a proposed central wood fired heating system to serve the space heating needs of a number of school buildings in Fort Smith, N.W.T. The major objectives of the work were: to develop a pipeline energy distribution system design to link the wood boiler plant to the various heating loads; to complete the overall design of the facility to the point where all technical issues were resolved; and to refine a capital cost estimate and economic viability analysis from previous studies based upon more precise engineering information in order to verify project economic viability.

The Fitz-Smith Native Development Corporation Ltd. (F/S NDC) is the proponent of the concept to sell heat energy to the GNWT - owners and operators of school buildings in Fort Smith. The buildings considered for heating from a centralized wood fuelled low pressure steam boiler plant are the J. B. Tyrrell Elementary School, P.W. Kaeser High School and adjoining Mt. Avens Women's Residence and Breynat Hall Men's Residence. To achieve the objectives of this work, the F/S NDC solicited proposals from a screened list of boiler system vendors for the supply, erection and start-up, on a turnkey basis, of a wood chip fired low pressure steam boiler plant. The plant consists of a single 7.0 million BTU/hr (2051 kw) wood chip fired boiler, a boiler building, a wood chip storage bin, and an automated wood fuel feed system. The F/S NDC also engaged the services of an engineering consultant to develop a technically viable design and specification for the pipeline steam energy distribution system.

The proposed distribution system is an underground, insulated piping arrangement based upon the RICWIL, INC. prefabricated insulated piping system concept. Three distribution loops are proposed, each one running from the boiler plant to one of the client building mechanical rooms. The piping system consists of prefabricated sections containing two steel pipes, each separately insulated, and the pair packaged into a common 10 gauge galvanized steel conduit. One line is used to convey steam to the client heating load. The second is used to return condensate from the client building to the wood boiler plant. Steam from the boiler plant is circulated directly through the building heating loops in two of the buildings. However, the steam energy is transferred to local circulating hot water loops via a heat exchanger in the third building, P.W. Kaeser High School.

The capital cost for the creation of the wood boiler facility was estimated to be $611,518, consisting of $250,000 for the boiler plant, $284,518 for the distribution system and 77,000 for other set up costs.

An operating scenario is proposed in which the operators hired for the boiler plant supervision activity also take on the responsibility to supervise the rest of the boilers in Fort Smith currently in GNWT-DPW custody. On that basis, an annual cost saving by adoption of the wood boiler system is estimated to be $121,362. This cost saving can be used to recover the original capital investment in 5.0 years.

F/S NDC is encouraged to enter a heat energy sales agreement in which the GNWT pays for energy at the prevailing energy cost for fuel oil in order to realize this economic payback period.

ÉVALUATION DES POSSIBILITÉS DE CHAUFFAGE AU BOIS

FORT SMITH (T.N.-O)

y compris une description générale et une analyse économique
de l'aménagement d'une chaudière à bois
desservant les écoles de district

Résumé

Première partie

Cette étude évalue la faisabilité technique et la rentabilité d'installer des systèmes de chauffage alimentés au bois afin de desservir certains établissements commerciaux et gouvernementaux de Fort Smith.

Ces établissements comprennent le nouvel édifice fédéral, le bureau de détachements de la GRC, l'édifice regroupant les principaux services du gouvernement des Territoires du Nord-Ouest (G.T.N.-O), l'édifice Winerack, le motel Pelican Rapids Inn, l'hôtel Pinecrest et le magasin de la Baie d'Hudson. Ces établissements sont situés tout près du centre-ville de Fort Smith dans un rayon de 125 m autour du site où sera construit le nouvel édifice fédéral. Le bâtiment de l'aéroport de Transports Canada, le centre des services d'aviation et le garage de l'aéroport ont aussi été pris en considération.

La possibilité d'installer des chaudières à eau chaude alimentées au bois destinées au chauffage individuel des établissements a été examinée. On a aussi considéré la possibilité d'installer une seule chaudière centrale à basse pression alimentée au bois, pouvant desservir tous les établissements du centre-ville, énumérés ci-dessus. Le concept propose que la vapeur soit acheminée à chaque établissement par un système de distribution souterrain.

L'inspection des systèmes de chauffage actuels des établissements indique qu'en général l'équipement est en bon état, aucune installation ne devant être remplacée pour le moment. Tous les systèmes peuvent être modifiés pour recevoir la vapeur à partir d'une chaudière centrale distante de l'établissement, ou l'eau chaude à partir d'une chaudière alimentée au bois située près du bâtiment. Il est à supposer que tout l'équipement de chauffage existant sera conservé en cas de besoin. Tous les établissements sont chauffés actuellement avec des chaudières à eau chaude alimentées au mazout léger ou avec des fournaises à air chaud, à l'exception de l'édifice Winerack, qui est chauffé à l'aide de chaudières à eau chaude alimentées à l'électricité.

En général, les propriétaires étaient ouverts à l'idée d'acheter de l'énergie thermique produite à partir d'une source éloignée et exploitée par un entrepreneur privé. Les propriétaires se sont montrés négatifs ou peu enthousiastes devant la possibilité d'acheter et d'exploiter eux-mêmes des chaudières alimentées au bois.

Les résultats de l'évaluation économique portant sur les chaudières individuelles au bois sont résumés dans le tableau ci-après. Le tableau indique les coûts de chauffage actuels; le nombre de cordes de combustible-bois séchées à l'air nécessaires pour subvenir aux besoins en chauffage; les coûts des immobilisations nécessaires à l'installation d'une chaudière au bois appropriée; les économies marginales réalisables grâce à l'utilisation du combustible-bois; et les indices de viabilité économique. La période de recouvrement indique en nombre d'années, les économies annuelles nécessaires pour recouvrer la mise de fonds initiale, en ne tenant pas compte de la valeur temporelle de l'argent. Un calcul de la valeur actuelle nette a été fait pour obtenir un indice pondéré de la viabilité du projet en tenant compte de la valeur temporelle de l'argent. La valeur actuelle des épargnes annuelles, escomptées à 7%, sur une durée de vie de 20 ans apparaît sur le tableau. À partir de ces données, seul le projet de l'hôtel Pinecrest et peut-être aussi le projet de l'édifice fédéral semblent viables économiquement. Le rapport d'efficacité fournit une classification de l'attrait des projets en utilisant le rapport de la valeur actuelle nette des épargnes sur les coûts des immobilisations exigés. Les projets avec les meilleurs rapports sont les utilisateurs les plus efficaces des fonds investis.

Le coût de la chaudière centrale alimentée au bois et du système de distribution desservant les établissements numéro 1 et 7 du centre-ville est estimé à 779 000 $. Si l'énergie vendue aux consommateurs ne dépassent pas les coûts actuels du mazout et si deux personnes sont nécessaires pour la supervision de l'installation, cette dernière ne pourra produire assez de revenus pour justifier les coûts annuels d'exploitation. Toutefois, les coûts en main-d'oeuvre et d'exploitation pourraient être réduits considérablement en combinant ce projet avec les autres projets qui ont été soumis. Une petite marge de profit pourrait alors être envisagée, ce qui ramènerait la période de recouvrement simple de la mise de fonds initiale à 14,7 années.

On recommande que la Fitz-Smith Native Development Corporation (F.-S.N.D.C.) n'aille pas de l'avant avec le projet d'acquisition d'un système de chauffage pour le centre-ville à moins que l'exploitation ne soit rattachée à un autre projet (voir plus haut), et que des subventions en capital non-remboursables dépassant 450 000 $ soient garanties. On propose aussi que la F.-S.N.D.C. s'associe avec un vendeur connu de chaudières afin de promouvoir la vente de systèmes individuels de chauffage alimentés au bois aux propriétaires des établissements où la viabilité économique est indiquée. De cette façon, des revenus issus de contrats et de l'approvisionnement en combustible-bois seront créés pour la F.-S.N.D.C.

Deuxième partie

Cette deuxième partie de l'étude comprend une description technique et une analyse de la viabilité économique d'un système de chauffage central alimenté au bois qui desservirait un certain nombre d'établissements scolaires de Fort Smith (T.N.-O.). L'étude avait pour principaux objectifs de concevoir un réseau de distribution de l'énergie au moyen de canalisations, reliant la chaudière aux divers établissements; d'effectuer la conception globale des installations en résolvant toutes les questions de nature technique; et, à l'aide d'études antérieures, d'évaluer le coût des immobilisations et la viabilité économique du projet en fonction de renseignements techniques plus précis.

La Fitz-Smith Native Development Corporation Ltd. (F.-S.N.D.C.) est le promoteur du concept visant à vendre de l'énergie thermique au gouvernement des Territoires du Nord-Ouest (G.T.N.-O.) qui est le propriétaire et l'exploitant des établissements scolaires de Fort Smith. Voici les écoles qui seraient desservies par la chaudière centrale à basse pression alimentée au bois: l'école élémentaire J.B. Tyrrell, l'école secondaire P.W. Kaeser ainsi que la résidence pour femmes Mt. Avens et la résidence pour hommes Breynat Hall, qui lui sont adjacentes. Pour atteindre les objectifs de ces travaux, la F.-S.N.D.C. a lancé, à un nombre limité de vendeurs de chaudières, un appel d'offres concernant la fourniture, l'aménagement et la mise en service d'une chaudière à basse pression alimentée aux copeaux, devant être livrée "clés en main". Les installations proposées comprennent une chaudière alimentée aux copeaux de 7 millions de BTU/h (2 051 kW), une construction pour loger la chaudière, un silo pour entreposer les copeaux et un système automatisé d'alimentation en combustible-bois. La F.-S.N.D.C. a également retenu les services d'un ingénieur-conseil qui a été chargé de dresser des plans et des devis techniquement viables du réseau de distribution de l'énergie thermique.

Le réseau proposé de distribution se compose de canalisations souterraines isolées suivant le concept des canalisations isolées préfabriquées mis au point par le RICWIL INC. On propose d'aménager trois circuits de distribution, reliant chacun la salle des machines de l'établissement à la chaudière. Le réseau de canalisations se composerait de tronçons préfabriqués contenant deux tuyaux d'acier isolés séparément, et le tout recouvert d'un conduit d'acier galvanisé commun de calibre 10. Le premier tuyau servirait à acheminer la vapeur à l'établissement; l'autre servirait à renvoyer le condensat de l'établissement à la chaudière à bois. La vapeur provenant de la chaudière circulerait directement dans les circuits de chauffage de deux des établissements; pour le troisième, l'école secondaire P.W. Kaeser, l'énergie serait transférée à des circuits locaux d'eau chaude au moyen d'un échangeur thermique.

Le coût des immobilisations de ce projet a été évalué à 611 518 $, soit 250 000 $ pour la chaudière, 284 518 $ pour le réseau de distribution et 77 000 $ pour d'autres dépenses d'établissement.

On propose de confier aux exploitants chargés de la supervision de la chaudière la responsabilité de surveiller les autres chaudières de Fort Smith, surveillance qui est actuellement effectuée par le ministère des Travaux publics du G.T.N.-O. Ainsi, l'aménagement des installations proposées permettrait d'économiser 121 362 $ par année, ce qui ramènerait la période d'amortissement à cinq ans.

La F.-S.N.D.C. est disposée à conclure avec le G.T.N.-O. un accord de vente d'énergie thermique en vertu duquel ce dernier paiera cette énergie au coût actuel du mazout afin d'atteindre cette période d'amortissement.

L'étude a été effectuée pour la Fitz-Smith Native Development Corporation par Manecon Limited avec une subvention du Programme de démonstration dans les collectivités éloignées d'Énergie, Mines et Ressources Canada.

VIABILITÉ DES CHAUDIÈRES COMMERCIALES ALIMENTÉES AU BOIS - FORT SMITH

ÉTABLISSEMENT	(1) COÛT ACTUEL DU CHAUFFAGE PAR ANNÉE	(2) COMBUSTIBLE-BOIS NÉCESSAIRE (CORDES PAR ANNÉE)	(3) COÛT DES IMMOBILISATIONS DES CHAUDIÈRES À BOIS	(4) ÉPARGNES ANNUELLES RÉALISÉES SUR LES COÛTS D'EXPLOITATION	(5) PÉRIODE DE RECOUVREMENT (3)/(4) (ANNÉES)	(6) VALEUR ACTUELLE* NETTE DES ÉCONOMIES	(7) RAPPORT* D'EFFICACITÉ (6)/(3)
1. Nouvel édifice fédéral	$ 21 052	85	$ 98 050	$13 738	7,1	$ 47 490	,48
2. Bureau de détachements de la GRC	8 233	33	94 500	4 495	21,0	-46 880	nul
3. Édifice regroupant les principaux services G.T.N.-O.	24 460	99	113 700	16 236	7,0	58 304	,513
4. Édifice Winsrack	15 000	42	102 400	10 606	9,6	9 960	,097
5. Motel Pelican Rapids Inn	18 466	75	116 300	11 870	9,8	9 451	,081
6. Hôtel Pinecrest	43 710	177	85 180	30 226	2,8	235 034	2,76
7. Magasin de la Baie-d'Hudson	19 999	81	129 300	5 486	23,6	-71 181	nul
8. Garage de l'aéroport de transports Canada	11 369	46	97 100	6 700	14,5	-26 120	nul
9. Aéroport de Transports Canada	6 400	26	89 770	3 107	28,9	-56 854	nul

* Voir hypothèses à la section 5.1

PART I
WOOD HEATING OPPORTUNITIES IN COMMERCIAL BUILDINGS

1.0 **INTRODUCTION**

The use of wood fuel in commercial building heating systems is virtually non-existent in the Northwest Territories. There are a number of positive indicators to suggest that wood fuel should be adopted in many of these instances, namely: wood fuel is significantly cheaper than fuel oil on a cost per unit energy basis; wood burning equipment now consists of reliable, efficient, automated systems requiring only occasional supervision; wood fuel use represents a shift from fossil fuel to a renewable energy source; wood fuel use captures fuel expenditure funds in the community and creates local employment.

The Fitz-Smith Native Development Corporation sponsored this project to assess the technical and economic feasibility of the installation of wood boiler heating systems to serve the heating needs of selected commercial buildings in the Fort Smith Community, both on an individual building basis, and through service from a common, central wood boiler heating plant.

Buildings selected for assessment represent the larger buildings, all located in close proximity, in the downtown core of the community. Additionally, buildings operated by the Federal Department of Transport at the local airport were considered in response to an interest expressed by the airport manager.

The first step in the project was to examine the heating systems in each of the buildings. The size, condition, type and mechanical tie-in requirements for each of the systems was noted. Records of fuel consumption, building occupancy pattern, recent building upgrading for energy conservation, etc. were assembled. These records, together with a description of the buildings and their current heating system are assembled in Chapter 2.0.

The attitudes of the existing building owners toward wood heating are an important determinant in the success of any wood heating system proposal advanced. Their impressions toward individual, building-dedicated, wood heating systems, and toward a central heating plant are summarized in Chapter 3.0. The business, financial, operational, or technical constraints the owners would impose on a wood heating system serving their building were also noted.

Specific boiler system equipment, suitable for the various installations considered, is identified and described in Chapter 4.0. The equipment is identified in order to more precisely define wood boiler heating system costs in later sections.

The economic viability of individual building wood boiler heating systems is determined in Chapter 5.0. The technical concept developed to form the basis for capital cost estimation is described. Tie-in arrangments are indicated. Capital costs and wood boiler facility operating and maintenance costs are estimated and assembled. Economic viability is indicated through computation of: investment net present value methods, and by the simple economic payback period approach. The sensitivity to economic viability due to changes in certain estimated cost assumptions is computed.

The economic viability of a downtown core central wood boiler heating plant is assessed in Chapter 6.0. A suitable technical concept, including underground flow line routing, is discussed. Capital costs to supply and erect a low pressure system boiler plant, to install the underground steam distribution system, are assembled. Economic viability and sensitivity considerations were computed in a similar fashion to Chapter 5.0.

Conclusions from the project are re-assembled in Chapter 7.0. Recommendations for future action are indicated.

A brief plan to guide the implementation of the project recommendations is offered in Chapter 8.0.

2.0 CANDIDATE BUILDINGS

2.1 GENERAL

The assessment of wood heating opportunities focussed upon eight buildings in Fort Smith. The buildings were:

	BUILDING	OWNER
1.	planned new federal building	Canada
2.	RCMP detachment office	Canada
3.	GNWT regional headquarters bldg.	GNWT
4.	Winerack building	local private
5.	Pelican Rapids Inn	non-local private
6.	Pinecrest Hotel	non-local private
7.	Hudson's Bay Store	Hudson's Bay Co.
8.	Airport buildings	Canada

The location of these buildings is indicated on the town map, Figure 2.1/1. The airport facilities are located on the western edge of the town (not shown) approximately 3 km. from the Pinecrest Hotel. All buildings except the airport facilities are located in close proximity and comprise the downtown core of Fort Smith. All of the core buildings lie within a radius of 125 metres from the new federal building.

The downtown core is situated on sandy soil enabling relatively easy trenching or foundation preparation for the installation of wood heating equipment or flow lines.

Flow lines burial must contend with asphalt paved two lane roads in the vicinity. Some concrete sidewalks exist. No concrete curbs or underground storm water drainage facilities exist.

The individual buildings are described in the following subsections. Fuel oil consumption for the various structures is tabulated in each case.

LEGEND:

1. Hudson's Bay Store
2. Pinecrest Hotel
3. Pelican Rapids Inn
4. Winerack Bldg.
5. RCMP Office
6. Proposed New Federal Bldg.
7. GNWT Regional Headquarters

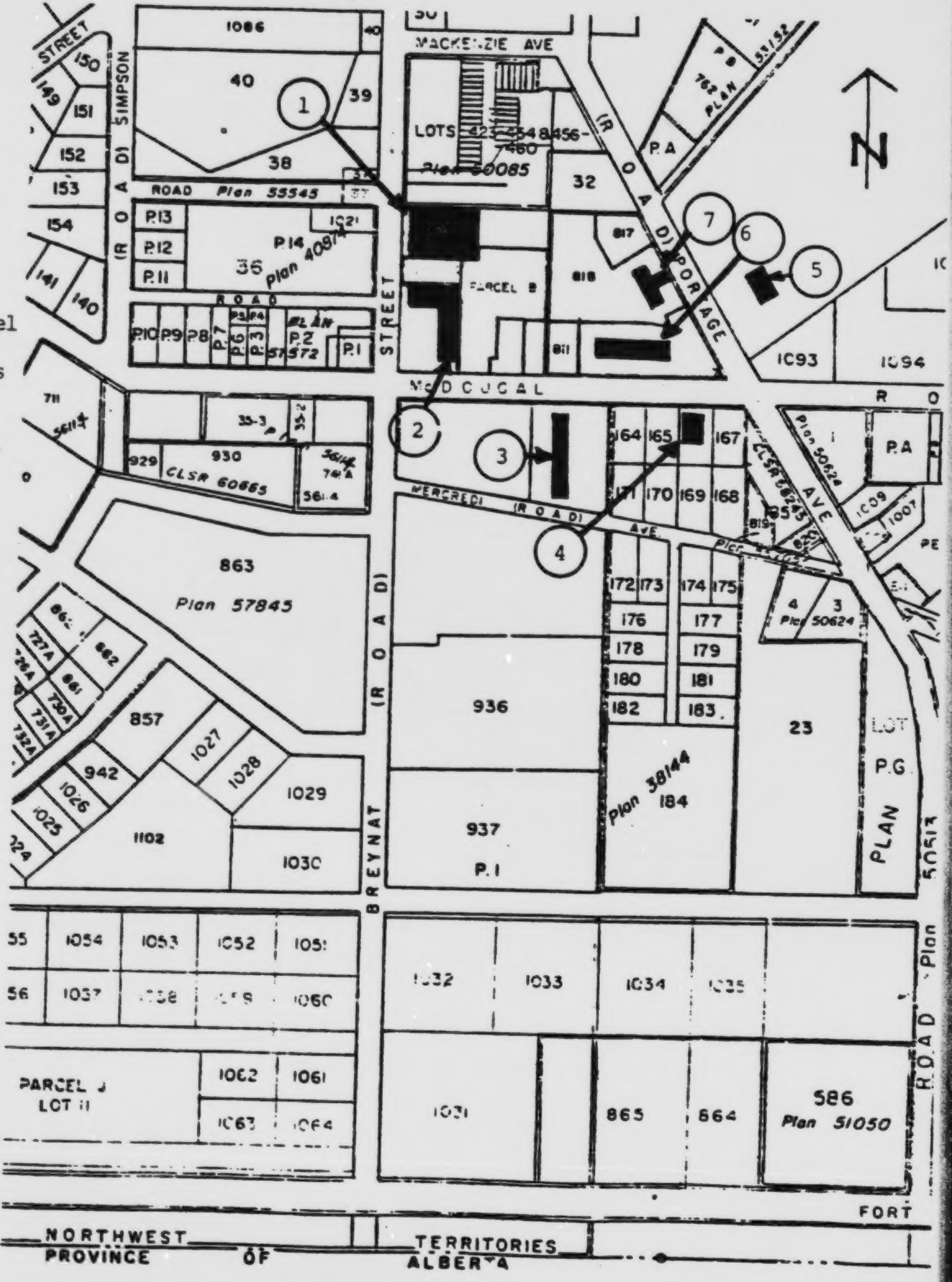
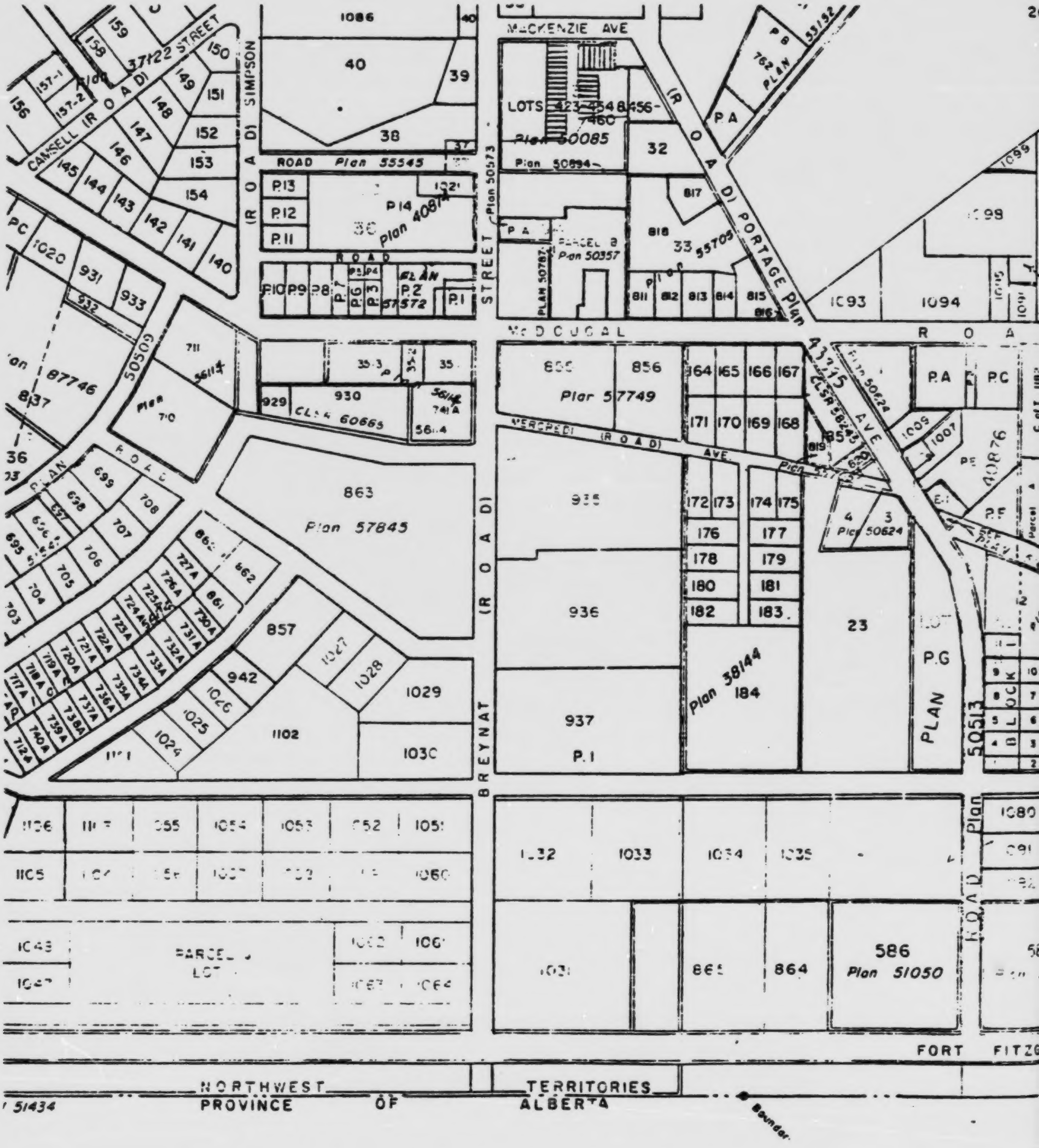

STREET
SIMPSON (ROAD)
MACKENZIE AVE
LOTS 423-454 & 456-460
Plan 60085
(ROAD) PORTAGE AVE
McDOUGAL ROAD
MERCREDI (ROAD) AVE
BREYNAT STREET (ROAD)
ROAD Plan 55545
Plan 40874
ROAD PLAN 57572
PARCEL B
CLSR 60665
Plan 57845
Plan 38144
Plan 50624
Plan 51050
PARCEL J LOT 11
N
1
2
3
4
5
6
7
1086
40
39
38
36
32
863
936
937
P.1
184
23
586
857
942
1102
1029
1030
1027
1028
1093
1094
P.A
P.G
FORT
NORTHWEST TERRITORIES
PROVINCE OF ALBERTA

FIGURE 2.1/1(a) PORTION OF TOWN MAP
TOWN OF FORT SMITH, N.W.T.
Scale: 1" = 400' approx.


MACKENZIE AVE
CANSELL (R O A D)
37122 STREET
SIMPSON (R O A D)
ROAD Plan 55545
P13
P12
P11
P14
Plan 40814
ROAD
PLAN 57572
P10 P9 P8 P7 P6 P5 P4 P3 P2 P1
LOTS 423-454 & 456-746C
Plan 50085
Plan 50894
PARCEL B Plan 50357
PLAN 50787
Plan 50573
Plan 55705
PORTAGE (R O A D)
Plan 53152
McDOUGAL R O A
MERCREDI (R O A D) AVE.
CLSR 60665
Plan 57749
Plan 57845
PORTAGE AVE
Plan 50624
Plan 43715
CLSR 58243
Plan 40876
Plan 38144
PLAN 50513
Plan 87746
50509
Plan 710
BREYNAT STREET (R O A D)
BLOCK
Plan 51050
FORT FITZ
NORTHWEST TERRITORIES
PROVINCE OF ALBERTA
Boundary
51434
1086
40
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817
818
811 812 813 814 815
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1098
1020
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942
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1102
1024
1025
1026
1101
929
930
35-3
35-2
855
856
164 165 166 167
171 170 169 168
172 173 174 175
176 177
178 179
180 181
182 183
184
935
936
937
P.1
23
P.G
P.A
P.C
P.E
P.F
1007
1009
4
3
586
864
865
1031
1032
1033
1034
1035
1106
1105
1055
1054
1053
1052
1051
1050
1061
1080
1091
PARCEL LOT

FIGURE 2.1/1(b) TOWN OF FORT SMITH
PROPERTY DESIGNATIONS

2.2 PLANNED NEW FEDERAL BUILDING

A new federal building is planned for Fort Smith to house the offices and facilities of the Department of Indian Affairs and Northern Development (primarily forestry related), Parks Canada (Wood Buffalo National Park), Post Office, and the Canada Employment and Immigration Centre. The building is to be located on town lots 812 to 815 inclusive on the north side of McDougal Road. The existing federal building, housing Parks Canada, and two houses will be demolished to make way for the building.

The building is to be occupied on basically a 40 hr. per week basis during the heating season. The Post Office space may be subject to slightly extended operating periods.

The building mechanical systems are intended to be supervised and maintained by the federal Department of Public Works maintenance staff located in Fort Smith. The staff maintain a variety of facilities in town. No personnel will be continuously assigned to the federal building operations on maintenance activity.

The new federal building has been completely designed under the supervision of Public Works Canada - Western Region, Edmonton. Tender documents and specifications have been prepared. The building was to go to construction tender in late spring 1984, but has been held up by senior political officials in Ottawa, pending review of a privately advanced proposal to build a building and offer equivalent space to Canada on a long term lease basis. Federal building construction is now not expected before the spring of 1985 (or totally cancelled if the private proposal prevails).

The proposed building is basically a rectangular structure with an approximately 60 metres long front wall facing the street and 15 metres long side walls. The building is approximately 30,000

ft^2 gross floor area. The post office is located on the east end of the building and will consist of a single storey, with no basement, with a total gross area of approximately 7,000 ft^2. The central and west end of the building consists of two storeys above ground, and a partial basement. The structure is a concrete block construction with a brick exterior finish. The boiler room is located in the basement along the north wall of the building. A single 9092 litre capacity fuel oil storage tank is to be buried in the NE corner of lot 814 to serve as the supply fuel tank for the boiler equipment.

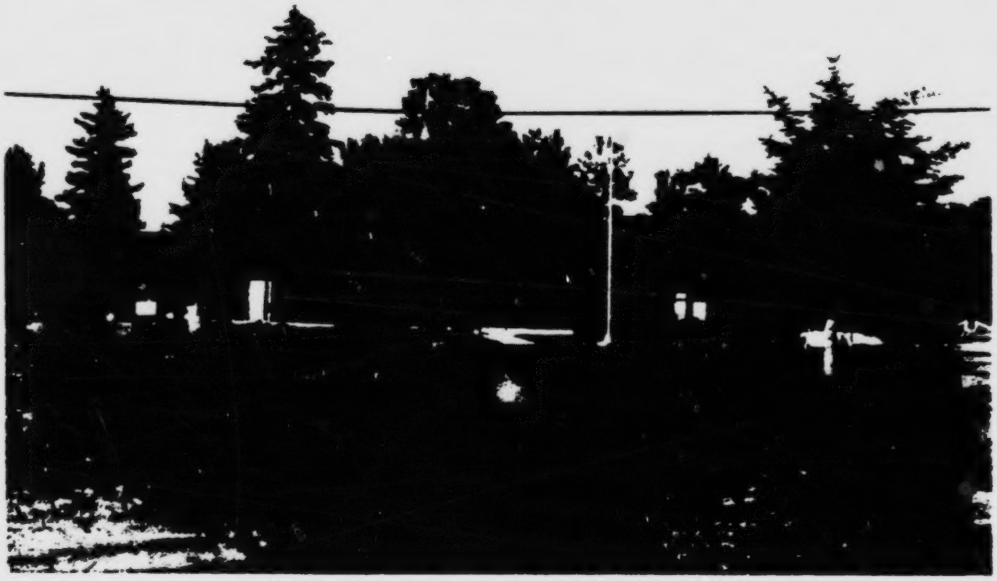
Two #2 light fuel oil fired hot water boilers were specified as the primary heating equipment for the facility. The units are to supply a common hot water supply manifold and will have common cold water return piping. The units are meant to operate generally in parallel. Each boiler is specified to be an H.B. Smith Model 2500 L-6 or equivalent, with an output capacity of 175.8 kw (600,000 BTU/hr).

The units were apparently sized to each carry approximately 2/3 of the expected peak heating load (with the building in a lights out, unoccupied condition).

Tie-in of an external hot water or steam supply source is most simply accomplished by pipe entry through the north foundation wall directly into the boiler room. With an external heat supply, Public Works Canada designers suggest that their boilers would be isolated in a wet storage condition. Cold water supply plumbing and the hot water supply manifold would require simple modifications to bypass the existing boilers and tie-in a heat exchanger to deliver heat from the external source.

The annual fuel oil consumption, projected for the building by computer analysis during the design, is 52,630 litres/year.

2.3 RCMP DETACHMENT OFFICE



The RCMP detachment office and jail facilities are a modern two storey building located approximately 75 metres east of the GNWT headquarters building. The structure, constructed in 1978, is of concrete block construction with a vertical cedar siding exterior. The main floor space is assigned to reception area, office space, lunch room-conference room, jail cell block, and two unheated garages. The second floor area, much reduced from the main floor area due to the high pitch roof design is assigned to one office, the furnace room, and a document storage room. The building has no basement. The building is estimated to enclose perhaps 5,000 ft.^{2} of gross floor area. The building is occupied on a continuous basis, due to the nature of the services rendered.

The office is heated by means of two Lennox model 057-189 oil fired hot air furnaces, located in the second floor mechanical room. The units are ceiling space configuration units (0.8m. high x 0.8m. wide x 3m. long) but are situated on the mechanical room floor for ease of access and servicing. Each unit has a rated output capacity of 151,000 BTU/hr. One furnace is used to heat the cell block and the back of the building. The second furnace is used to heat the offices, reception area and front end of the building.

The furnaces were reported to be in operation almost continuously on cold winter days suggesting that building peak heating load may be in the 250,000 BTU/hr range. Air infiltration around main floor windows was reported as significant. The building is fitted with a John Wood model 537 water heater. The 70 U.S. gallon capacity oil fired unit is located in the mechanical room.

Access to the second floor mechanical room with a pipe carrying externally generated hot water or steam for heating purposes is possible by entry through the building wall at the second floor level at the north end or the south end of the building. Alternately, entry at ground level into the north end of the building may be possible with a delivery pipe running up into the mechanical room inside the building envelope. Delivery of heat to the existing system is accomplished by placing heat transfer coils in the supply plenums of the existing furnaces. The coils are fed with hot water or steam from the external source.

The present furnace equipment is not supervised on a regular basis. Annual servicing is contracted for through Public Works Canada local crews, and the furnaces are occasionally checked at random by the occupants, throughout the heating season. The furnaces appear to be well maintained. The units can be expected to provide service for a normal 25 - 30 year lifetime.

Fuel consumption records for the detachment office heating system (water heating is lumped in also) are summarized below. Domestic hot water consumption was suggested to be as per a normal household with occasional showers by staff, detainees, and hot water use for washrooms, etc.

Time Period	Fuel Quantity
October, 1982	1,465 litres
November, 1982	3,638 "
December, 1982	2,792 "
January, 1983	3,750 "
February, 1983	3,719 "
March, 1983	2,658 "
April, 1983	-0-
May, 1983	-0-
June, 1983	-0-
July, 1983	-0-
August, 1983	-0-
September, 1983	-0-
October, 1983	3,835 litres
November, 1983	4,244 "
December, 1983	3,610 "
January, 1984	2,546 "
February, 1984	3,689 "
12 Month Total	20,582 litres
	@ $.325/litre = $6,689.00

Fuel quantities were taken from fuel oil delivery invoices.

Two duplex units comprise the staff housing used by the officers and their families. The duplexes are located approximately 50 m. N.E. of the detachment office. Annual fuel consumption for each half of these duplexes was recorded to be, in each case, approximately 2500 litres, 2700 litres, 3000 litres, and 3100 litres.

A maintenance garage, located east of the detachment office, is occasionally heated in winter months. The recorded annual fuel consumption of the garage was approximately 1600 litres.

2.4 GNWT REGIONAL HEADQUARTERS BUILDING

The Regional Headquarters Building is a three storey wood frame structure built on a concrete foundation. The basement is also developed for office occupancy. The building provides office space for various departments of the GNWT serving the Fort Smith Region (which includes Hay River, Snowdrift, Rae Edzo, etc.) Occupancy is typically on 40 hrs/week basis.

The Regional Headquarters Building is situated at the east end of lot 818 (see town map on Figure 2.1/1).

The 'T' shaped structure appears to be circa 1940's construction with wood framed windows, a slate board exterior finish and a shallow pitched roof. The building has approximately 5,700 ft^2 (530 m^2) gross floor area per floor (17,100 ft^2 overall).

The building heating system consists of three hot water boilers. One boiler, a Viking 7.8 b.h.p. (261,000 BTU/hr unit) is dedicated to service the 'T' portion of the building. The unit is supplied from a 7,500 litre fuel storage tank. This single boiler is located separately in a boiler room in the basement of the 'T' addition. Access to the room with pipes carrying externally generated heat can be through the north facing concrete exterior wall. The age of the boiler was not determined. The unit was reported to be in fair condition and was estimated to be servicable for another five years or more.

The majority of the building is heated by means of two hot water boilers, a Viking 7.5 b.h.p. (251,000 BTU/hr) cast iron sectional boiler, and a 11.2 b.h.p. (375,000 BTU/hr) Warden King boiler. The units supply a common hot water manifold that distributes hot water to seven zones throughout the building. The units are operated more or less in tandem and collectively have a 50 - 60% running time during cold winter periods. The boilers are supervised on a twice per day spot check basis by GNWT Public Works Maintenance staff (located elsewhere in town). The twin boilers are fuelled from a 75,000 litre fuel storage tank. The boilers were reported to be in good condition and are expected to be servicable for ten or more years.

The twin boilers are situated in a basement room adjacent to the east facing concrete exterior wall of the building. If the building was supplied with heat from an external source, located to the west of the building (a likely site), external piping could enter the building east wall at the main boiler room, and continue some 20 metres along the basement roof to the auxiliary boiler room. Space exists in each boiler room for appropriate tie-in plumbing.

The fuel consumption for the headquarters building for the 1983/84 fiscal year is tabulated in Table 2.4/1. The fuel consumption data are really fuel delivery quantities accumulated over each monthly reporting period. The quantities are taken from the fuel truck fuel delivery meter readings.

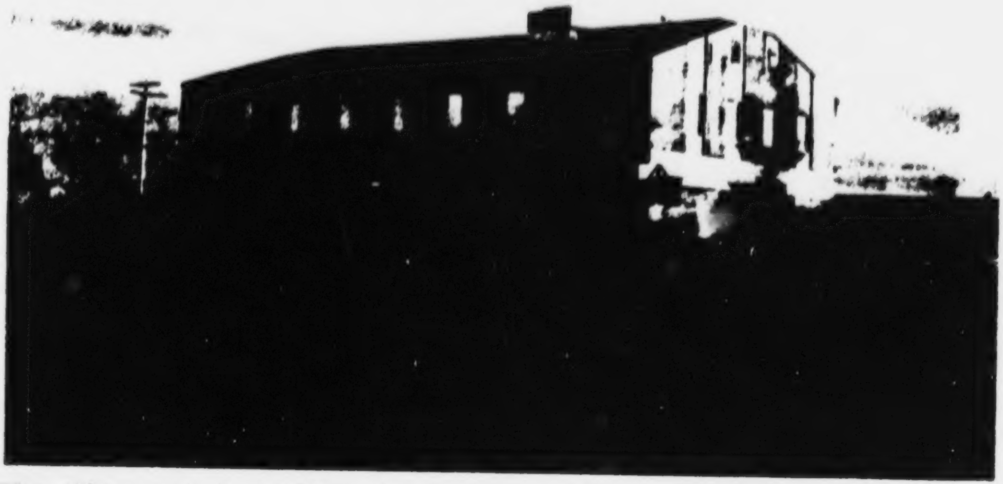
An unusually large September fuel quantity is shown in the Table. The records were double checked to substantiate this figure. The on-site tankage may have been more empty than usual due to short deliveries in the spring.

TABLE 2.4/1 FUEL CONSUMPTION
GNWT REGIONAL HEADQUARTERS BUILDING
FISCAL YEAR 1983/84

DATE	QUANTITY * (litres)	RATE ($/L)	COST
March, 1983	2,702		
April	937		
May	--		
June	--		
July	--		
August	2,066		
September	12,451		
October	4,732		
November	9,242		
December	9,924		
January, 1984	11,390		
February	7,705		
TOTAL	61,149 Litres @	$0.363 =	$22,197.00

* taken from fuel delivery invoices

2.5 WINERACK BUILDING



The Winerack building is a two storey wood frame commercial building located on the south side of McDougall Road opposite the new Federal Building. The building, constructed in 1978, is 50' x 84' in plan dimensions, with 4200 ft.^{2} of developed space on each floor, plus a fully developed basement. The top floor is office space and is occupied by the GNWT on a 40 hours/week basis. The main floor is partitioned into two parts for the tenants. The north end of the main floor is office space, occupied by CEIC on a 40 hour/week basis. The rest of the floor is occupied by the Winerack restaurant and lounge. The restaurant kitchen is on the main floor south end. The restaurant is open for business approximately 12 hours/day on weekdays, and 6 hours/day on weekends.

The concrete full basement is developed to include a banquet hall (25' x 84'), banquet room storage area, restaurant food storage area, washroom facilities and building mechanical room. The basement is 12' deep and features a T-bar suspended ceiling finish to permit easy access to plumbing and electrical distribution.

The Winerack Building is owned and operated by a local Fort Smith businessman.

The building is heated by means of electricity with two separate systems. The upstairs floor (GNWT occupancy) is heated by electrical baseboard heaters (220 V) placed throughout the habited space. Electricity consumed on the upper floor for heating, lighting, air conditioning or office machine use, is separately metered and paid for directly by the GNWT. The electricity charge to the GNWT was reported to be $3,500 - $4,000 per annum.

The main floor and basement is heated by means of an electrically heated hot water boiler system located in the basement mechanical room. Two Chromatix Model CCEF-144 packaged electric hot water boilers are plumbed in parallel. The units are supplied from a common 2" diameter copper cold water return line, and discharge 170°F hot water to a 2" diameter copper supply. Hot water is circulated to four building zones throughout the main floor and basement by a centrifugal pump located on the boiler cold water return line. The boiler supply and operating controls are functionally identical to that of an oil fired boiler. Electrical element operation is controlled by water supply temperature. High temperature limit, low water limit controls, etc., are in place. Electrical energy to the boilers is supplied by a single 600 V 3 phase transformer also located in the mechanical room. Each boiler has a rated peak capacity of 144 kw. It was reported that the peak heating load for the electric boilers requires the units to operate in tandem on a 70-80% on-time basis. The electrical energy consumption for heating is not accurately known since main floor and basement electricity is singly metered and includes consumption for lighting, restaurant kitchen operation and dining room air conditioning. The owner's experience suggested that $15,000 per annum in electricity charges can be allocated to main floor and basement heating costs.

The boilers were installed during building erection in 1978, are reported to be in very good condition, and are expected to have a 35 year lifetime.

Tie-in of an external hot water or steam heat source will be limited to serving the heating load of the basement and main floor of the building. Replacement of the second floor electrical heating system with a hot water distribution system is not contemplated. Tie-in to the existing boiler flow lines will be straight forward. The 10' x 16'x 12' ceiling mechanical room has plenty of spare room off floor level to position a heat exchanger to deliver steam or hot water energy to the local water distribution system. The existing cold water return is very accessible to permit a redirection of the line down stream of the circulating pump to pass through the exchanger, and back into the common boiler inlet line. The mechanical room is located at the midway point along the 84' building length, and is adjacent to the west exterior foundation wall. An external heat supply line could enter the building enclosure at any location and rapidly run through the basement ceiling space (above the T-bar finish) to the mechanical room, or could enter through the mechanical room exterior wall directly.

The present heating system is operated essentially in an unattended manner. The restaurant operator and building owner check on the boilers on occasion, with control adjustments periodically made by the owner. Mechanical maintenance is generally contracted to local qualified tradesmen as required.

2.6 PELICAN RAPIDS INN

The Pelican Rapids Inn is a two-storey motel located on McDougal Road, Lot 856. The long rectangular shaped structure is built of frame construction. The motel has a metal siding exterior finish. The original building, including approximately 30 units, manager's quarters, office and housekeeping facilities, was constructed in 1972 -74. The motel was extended by approximately 30 units in 1980. The building is erected on a concrete perimeter wall foundation. A full building width, full length, four feet deep crawl space exists under the main floor of the motel. A full basement exists under the office and manager's suite at the building north end.

The motel has a plan area of approximately 220' x 40', per floor, or a gross building area of 17,600 ft^2 overall. The building is surrounded with an asphalt apron for vehicle parking. The apron extends to the property line on the west and south boundaries.

The motel rate of occupancy varies substantially from day to day.

Weekend occupancy may be 15% in the winter and ocassionally 30 - 40% in the summer. Weekday occupancy (Monday night to Thursday night) is frequently 70% or better and is completely full perhaps 10% of the year.

The heating system for the motel consists of two separate systems, one installed with the original building, a second for the 1980 addition. The original system is located in the basement at the north end of the motel under the office and managers suite area. This system consists of two Weil McLean model B-473 oil fired hot water boilers. One unit is rated at 259,100 BTU/hr output capacity; the second at 223,600 BTU/hr. The units operate independently. One unit supplies heat to baseboard radiators in the main floor rooms, the second supplies heat to the upstairs rooms. The boilers are known to operate on a high duty cycle during cold winter conditions.

The basement room has concrete walls. Outside access to the boiler room is most direct through the east wall. Plenty of room exists in the boiler room area to install heat exchanger equipment to deliver externally generated heat to the building distribution lines.

The physical operating condition of the boilers was not accurately known. The units were guessed to be in fair to good condition and probably have 10+ years of useful remaining life. Maintenance and servicing has been kept up reasonably well.

An oil fired domestic hot water heater (2.0 U.S. gal/hr. oil burning rate) with an extra hot storage tank is also located in the basement boiler room.

The heating system serving the motel addition consists of a single Weil McLean oil fired hot water boiler located on the main floor at the north end of the addition, or perhaps 40% along the length of the whole motel, from the south end. The boiler has an output capacity of 292,200 BTU/hr and is used to supply hot water heat to both the main floor and upstairs in the motel addition. The small boiler room is perhaps 10' x 14' in area and is located in the center of the building span, without direct access to a building exterior wall. The boiler room is situated on a concrete floor. (The floor is wood frame in the motel area). An 84 U.S. gal/hr. hot water heater and 80 gal. hot water storage tank are also located in the boiler room. Piped heat access to this boiler room is best achieved by creating a hole in the concrete floor and running piping through an exterior wall through the under floor crawlspace, into the boiler room.

The new addition is reported to be cool during very cold winter conditions, suggesting either the additional boiler is slightly undersized or the water distribution loop requires some optimization, or air infiltration losses should be reduced.

The heating systems are monitored as part of the general duties of the motel manager. As such, the equipment receives periodic maintenance from contracted tradesmen and otherwise is left to run unattended. Energy conservation practises are followed whereby room thermostats are set back during days of vacancy.

The fuel oil consumption for the motel was assembled for the 1983 - 84 winter heating season. The data from fuel delivery invoices is presented in Table 2.6/1. The fuel consumption also includes fuel used for domestic hot water heating purposes.

TABLE 2.6/1

FUEL OIL CONSUMPTION
PELICAN RAPIDS INN
FISCAL YEAR 1983/84

DATE	QUANTITY (litres)	RATE ($/L.)	COST
June, 1983	2,969		
July	890		
August	1,108		
September	1,884		
October	3,200		
November	5,661		
December	7,768		
January, 1984	6,946		
February	5,829		
March	3,686		
April	3,350		
May	2,874		
TOTAL	46,165 Litres @	$.395 =	$18,235.00

2.7 PINECREST HOTEL

The Pinecrest Hotel is a two storey "L" shaped complex located on the NE corner of McDougal Road and Breynat Street. The building is built from wood frame construction and is perhaps 30 - 40 years old. The exterior finish is stucco and some siding. The main floor of the complex is used for lobby and registration area for the hotel, lounge and bar, fast food outlet, coffee shop restaurant, beauty parlor, small clothing store. The hotel rooms are located on the second floor. The building gross area is approximately 12,000 ft.^{2} per floor, 24,000 ft.^{2} overall. A basement is located under the north wing or 'foot of the "L"' portion of the building. The concrete wall basement is partitioned into a number of rooms including food storage, hotel fixtures storage, walk-in cooler, boiler room.

The heating system consists of two Warden King hot water boilers, each with an output heating capacity listed at 859,000 BTU/hr. The boilers operate in tandem and supply a common hot water supply manifold. The building is segregated into heating zones each served by a separate hot water distribution loop. The boiler units are reported to be in good shape and are expected by the owner to last another 10 - 15 years.

The two boilers and the domestic hot water heater are supplied with fuel from a 4,300 litre storage tank located outside the building adjacent to the north wall. The boiler room itself is located in the northeast basement corner of the complex. The room does not have sufficient space to add a wood boiler unit, but could easily accommodate heat exchangers or tie-in plumbing.

Electrical distribution panels and conduit, together with heat distribution lines occupy much of the north wall face. A wood boiler could not be located at ground level on the east side of the complex since the building is located very close to the property line. A storage room located in the basement adjacent to the north wall, approximately 5 - 7 metres from the existing boiler room may be convertible to use as a wood boiler room. Installation of the boiler would require opening the north concrete wall below grade.

The existing oil fired hot water boilers are generally supervised by the resident hotel manager. In reality, the boilers are left to run unattended, and are checked on a casual random basis or in the event of heating system upset. Most boiler maintenance is contracted out.

The annual fuel cost to operate the heating and domestic hot water supply for the Pinecrest was $42,387.41 in fiscal year 1983. The record of fuel delivery invoiced amounts is presented in Table 2.7/1.

TABLE 2.7/1

FUEL CONSUMPTION
PINECREST HOTEL
FISCAL YEAR 1983/84

DATE	QUANTITY * (litres)	RATE ($/L.)	COST
March, 1983	11,612	$0.386	$4,482.23
April	6,448	.386	2,488.93
May	4,293	.386	1,657.10
June	--		
July	--		
August	7,234	.390	2,821.26
September	--		
October	8,695	.390	3,391.05
November	14,996	.390	5,848.44
December	19,189	.390	7,483.71
January, 1984	18,353	.3874	7,109.90
February	18,454	.385	7,104.79

TOTAL 109,274 Litres @ $0.3879 = $42,387.41

* taken from fuel delivery invoices

2.8 HUDSON'S BAY STORE

The Hudson's Bay Company operates a large modern clothing, dry goods, and grocery outlet in Fort Smith. The concrete block and steel frame single storey structure is located east of Breynat Street and north of the Pinecrest property. The rectangular building, constructed 3 - 5 years ago, has an approximate floor area of 30,000 ft.^{2}. The west end of the building (11,000 ft.^{2}) is occupied by the food store, food freezers, and food storage space. The east end of the building is occupied by the department store (19,000 ft.^{2}). Dry goods inventory storage is located in the rear of the store (along the south wall). A 20' ceiling exists in the building. A 12' tall drop ceiling is suspended in the department store public area, and the common lobby space. A framed 12' tall ceiling is built over the food store public area.

The building is finished on the exterior with vertical aluminum siding. Windows exist on the north face only. The surrounding lot to the building is gravel surfaced. No concrete surfacing exists on the east and south faces of the building.

The building is occupied on a 55 - 60 hour per week basis with typical public shopping hours.

The building is heated with four identical Powrmatic oil fired hot air furnaces. Two units are located side by side, suspended from the building ceiling in the food store supplies storage area, and provide heat to the food store. The second pair of furnaces are suspended from the ceiling in the dry goods storage area. A system of ductwork distributes hot air through the building. Each furnace has a rated output capacity of 200,000 BTU/hr.

A roof mounted air conditioning system is installed. Cooling units are built into the furnace supply plenums of the furnaces. The air conditioning is very seldom used.

A stand alone wood boiler unit would be most suitably located on the outside south wall or the east wall of the building. Hot water or steam generated would be piped to heat transfer units, to be added to the existing furnace plenums.

Energy consumption records for the food store and the retail department store are shown in Tables 2.8/1 and 2.8/2. Fuel oil consumption for the food store was 25,641 litres ($9,752.06) in fiscal year 1983. The electrical energy costs for lighting, freezer compressors, etc. amounted to $25,820 or 2.5 times more, for the same period. Note also that the food store heating system is active throughout the summer. The food store manager reported that the chilling effect from the food display coolers is sometimes excessive even in the summer and make up heat is supplied to keep the store comfortable.

The heating fuel consumption is 24,357 litres ($9,120) in the larger retail department store area. The electrical costs for lighting, store displays, etc. are $12,928 per annum.

TABLE 2.8/1

FUEL OIL AND ELECTRICAL ENERGY CONSUMPTION
HUDSON'S BAY FOOD STORE
FISCAL YEAR 1983/84

DATE	FUEL OIL CONSUMPTION	COST	ENERGY USE (MW. HRS)	COST
February, 1983	2,526 L.	$ 888.00	26.5	$ 1,929.00
March	2,232	792.00	26.0	1,898.00
April	3,648	1,341.95	26.0	2,017.00
May	2,357	909.80	31.1	2,360.00
June	--	--	--	--
July	1,218	476.24	26.7	2,073.00
August	--	--	--	--
September	1,433	559.00	30.4	2,313.00
October	2,165	844.00	27.6	2,130.00
November	1,333	520.00	32.0	2,417.00
December	5,321	2,075.00	32.6	2,459.00
January, 1984	3,408	1,346.07	25.4	1,989.00
TOTAL	25,641 L.	$9,752.06	339.1	$25,820.00

TABLE 2.8/2

FUEL OIL AND ELECTRICAL ENERGY CONSUMPTION
HUDSON'S BAY RETAIL STORE
FISCAL YEAR 1983/84

DATE	FUEL OIL CONSUMPTION	COST	ENERGY USE (MW. HRS)	COST
February, 1983	3,894 L.	$1,377.00	12.0	$ 991.00
March	6,099	2,253.00	10.5	893.00
April	6,099	2,254.00	12.9	1,103.00
May	--	--	12.8	1,160.00
June	--	--	9.7	894.00
July	--	--	12.5	1,056.00
August	--	--	14.2	1,252.00
September	1,665	649.00	11.7	1,086.00
October	265	103.00	11.0	1,101.00
November	4763	186.00	13.4	1,195.00
December	3,399	1,326.00	12.9	1,164.00
January, 1984	2,460	972.00	10.9	1,033.00
TOTAL	24,357 L.	$9,120.00	144.5	$12,928.00

2.9 FORT SMITH AIRPORT FACILITIES

The location of the Fort Smith airport and the layout of facilities are illustrated in Figures 2.9/1 and 2.9/2. The Department of Transport - Canada operates the airport facility, which includes an air terminal building (T83 - see map), an air operations building or flight service centre(T35), and maintenance facilities (T52 and surroundings). The buildings that represent potentially significant heat loads are described in the following paragraphs. The heating systems are basically maintained by the DOT staff on site, with ocassional assistance from the Public Works Canada staff in Fort Smith.

T52 Maintenance Garage

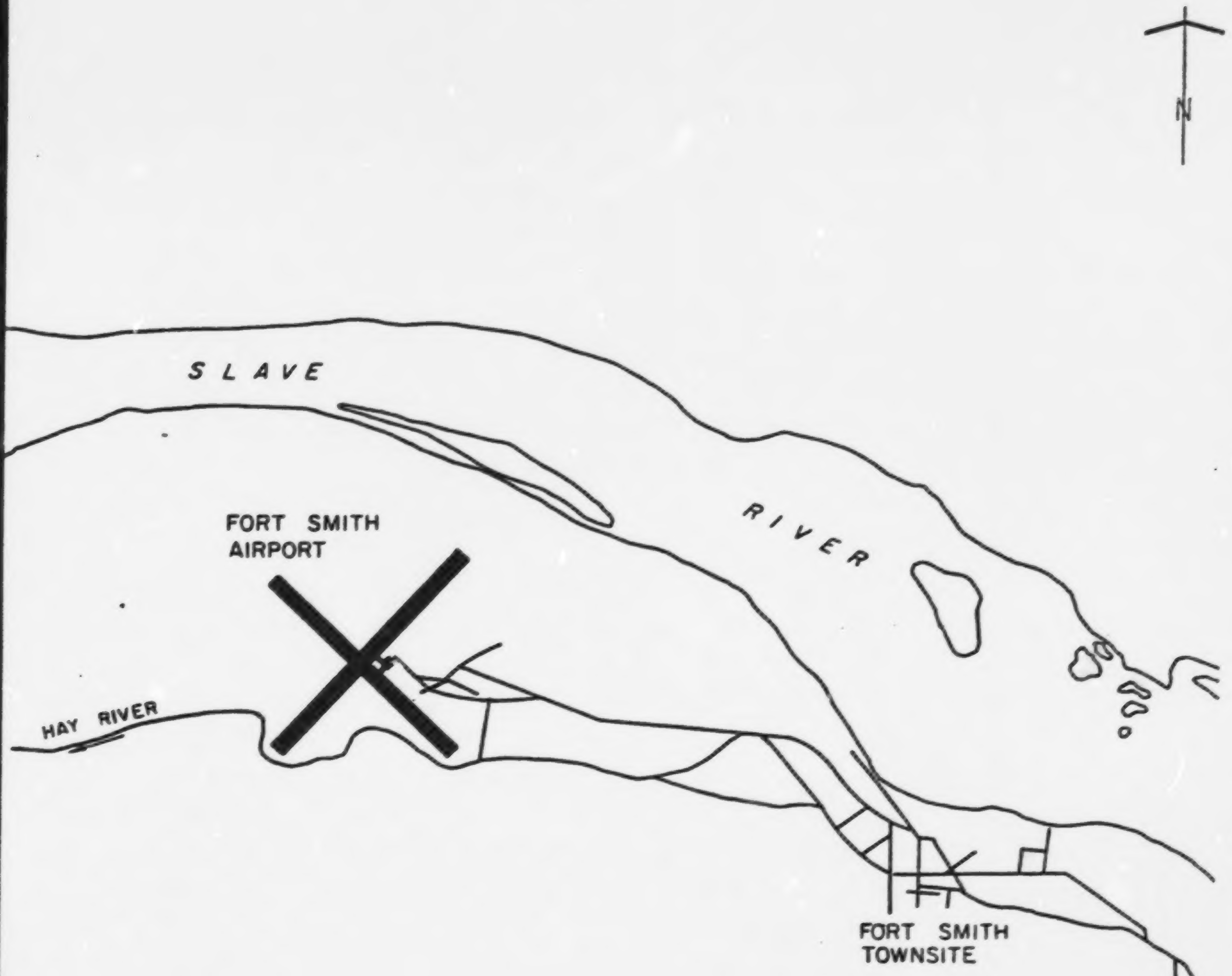
The main vehicle maintenance facility for DOT is a 102' x 80' single storey (20' ceiling) garage, located approximately 1200' east of the terminal. The building is an insulated steel framed structure built on a concrete perimeter foundation and concrete floor. Two large roll-up doors for vehicle access are located on the building south face; with one vehicle door on the east face. The building was initially constructed in 1962. A new exterior (metal siding) and insulation were added in the summer of 1983.

The building area is mostly dedicated to open shop area. An office and parts area are located in the SW corner of the building. The boiler room is located in the NW corner of the building. The building is used on a 40 hour per week basis.

The heating system for the maintenance garage consists of two Cleaver Brooks, Progress model P142-25 oil fired hot water boilers. Each unit has a rated output capacity of 837,000 BTU/hr. The building peak load is such that one boiler can comfortably meet the peak winter demand. The boilers supply a common hot water distribution manifold. Extra blank flanged ports exist on the manifold to facilitate other tie-ins. An air handling unit, equipped with a heat transfer coil supplied from the boiler manifold, is located along the boiler room roof line. This unit supplies hot air to the office area.

The boilers were installed with the initial construction in 1962. One unit developed leakage problems and was retubed in 1968. The units were reported to b in fairly good condition, and may be expected to last another 5+ years before any substantial age related problems develop.

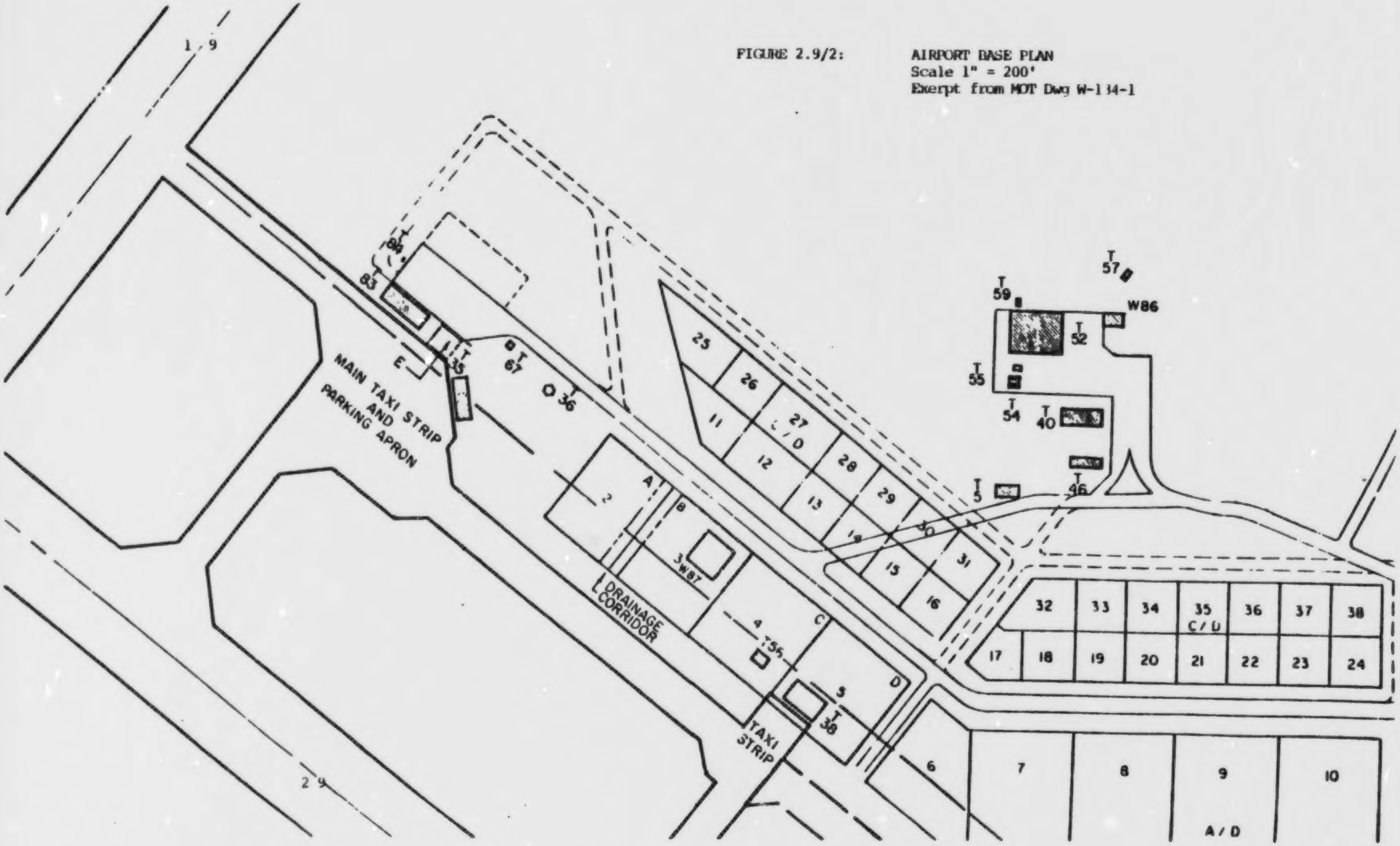
A stand alone self contained wood boiler plant could be conveniently located at the NW corner of the building. Heat supply pipes could easily run into the boiler room for tie-in to the existing hot water manifold. The boiler room does not have sufficient floor space to place a wood boiler but does have adequate room for additional piping. the wood boiler could, alternately, be located in the main shop area just east of the present boiler room. Wood feed and chimney exhaust would pass through the north wall.


N
SLAVE
RIVER
FORT SMITH
AIRPORT
HAY RIVER
FORT SMITH
TOWNSITE

KEY PLAN
SCALE: 1:50,000

FIGURE 2.9/1 LOCATION OF FORT SMITH AIRPORT

FIGURE 2.9/2: AIRPORT BASE PLAN
Scale 1" = 200'
Exerpt from MOT Dwg W-134-1


1 9
2 9
MAIN TAXI STRIP AND PARKING APRON
DRAINAGE CORRIDOR
TAXI STRIP
E
A
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3 W87
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5
T 83
T 84
T 35
T 67
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T 38
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10
A/D

BUILDING #	DESIGNATION	OWNER
T5	Power House	D.O.T.
T35	Operations Building	D.O.T.
T36	Revolving Beacon	D.O.T.
T38	Hangar	D. of I.A.
T40	Warehouse	D.O.T.
T46	Workshop	D.O.T.
T52	Maintenance Garage	D.O.T.
T53	Regulator Structure	D.O.T.
T54	Vehicle Fuel Tank U/G 1 - 2000 gal. diesel	D.O.T.
T55	Vehicle Fuel Tank U/G 1 - 1000 gal. gas	D.O.T.
T56	Storage Building	Gateway
T57	Sewage Lift Station	D.O.T.
T59	Heated Oil Tank 1 - 3000 gal.	D.O.T.
T67	Fire Hose House	D.O.T.
T83	Air Terminal Building	D.O.T.
T84	Fuel Oil Storage Tank 1 - 2000 gal.	D.O.T.
W86	Sand Storage Building	D.O.T.
W87	Hangar	Buffalo

T83 Terminal Building

The terminal building is a single storey, 39' x 97' (3,783 ft.^{2}) structure located adjacent to the main taxi strip. The building, erected in 1979, includes a large central passenger holding area, an airline service counter and baggage and freight handling area on the east end, and the airport manager's office in the west end. The building features a shallow pitched roof, metal clad exterior, and full length windows on the north and south walls in the passenger holding area.

The terminal presently hosts two passenger jet flights per day (13 per week in total). Each flight creates building occupancy for perhaps 1.5 hours.

The building is heated by two small Hydrotherm hot water boilers, both sharing a common cabinet. The units have a combined output capacity of 584,000 BTU/hr. The boilers share a common cold water return and supply a common 3" dia. copper pipe hot water manifold. The Hydrotherm equipment was suggested to be in fair to good condition. Five to ten years of reliable service is still expected.

The boilers are located in a small room at the north west corner of the building. Space exists in the room to add a heat exchanger and additional piping from an external heat source. Insufficient space exists to house an additional wood fired boiler unit.

The boiler room has a separate exterior access door on the west wall.

T35 Flight Service Centre

The Flight Service Centre is a single storey building with full basement, located on the aircraft parking apron east of the terminal. The 23' x 83'building was erected in 1957. The wood frame structure was thermally upgraded in the spring of 1984 with extra insulation and a metal clad exterior. The centre is staffed to provide weather information and assistance to aircraft in the vicinity.

The building is heated by a single Cochran oil fired hot water boiler with an output capacity of 165,000 BTU/hr. The unit is located in a basement room in the middle of the building, with direct access to the south west exterior concrete foundation wall (aircraft apron side). The unit was reported to be in surprisingly good condition for an old unit (1957) and could easily provide reliable service for another 5 years.

W86 Sand Storage Building

The sand storage building is a 30' x 37' x 18' tall (26' peak) structure located just east of the main maintenance garage. The side walls consist of an 8' tall concrete retaining wall and uninsulated steel siding on the upper portion. A roll up door for vehicle access is located on the west wall.

The building is used for dry storage of runway gravel - a gravel consisting screened stones of 1/16" - 1/8" diameter only. The building is heated to 15°C in the winter if the gravel was delivered wet - or is left unheated if the gravel has been dried. The building is heated by a 93,000 BTU/hr oil fired Olsen hot air furnace.

Fuel consumption records for the various D.O.T buildings were available covering a three year period. The data is taken from fuel delivery tickets. Deliveries are made to each tank on an once per month basis to top up the tanks in the warmer months, and two or three times per month in the four coldest months. Fuel consumptions are retabulated in Table 2.9/1. Note that annual fuel totals can vary simply due to the different amount of fuel left over in the tanks at each year end.

TABLE 2.9/1

FUEL OIL CONSUMPTION
DEPARTMENT OF TRANSPORT
FORT SMITH AIRPORT FACILITIES

	--- ANNUAL FUEL OIL UTILIZATION ----					
BUILDING	* T52	T83	T35	W86	T5	T40
FUEL TANK SIZE (Litres)	13,600	9,000	10,200	2,300	1,150	--
FUEL OIL CONSUMPTION (Litres)						
Apr/81 - Mar/82	38,066	14,155	11,752	9,279	3,586	6,923
Apr/82 - Mar/83	36,983	14,108	13,318	2,684	2,983	3,436
Apr/83 - Mar 84	28,423	19,732	11,808	12,233	2,866	5,384
	NOTE 1		NOTE 2	NOTE 3		

* BUILDING:

T52	Maintenance Garage
T83	Terminal Building
T35	Flight Service Centre
W86	Sand Storage
T5	Power House
T40	Warehouse

NOTE 1: The effects of a summer 1983 building insulation upgrade are noticeable.

NOTE 2: The effects of a summer 1984 building insulation upgrade will be seen in future data.

NOTE 3: The fuel use is erratic. Some winters the runway gravel is wet, requiring heated storage; other winters, with dry gravel on hand, require little heat.

3.0 OWNER INTEREST, ATTITUDES AND CONSTRAINTS APPLIED TO WOOD HEATING

3.1 GENERAL

The attitudes of the building owners and their heating system operators are an important factor in adopting, and making a success of wood heating technology. Owners will make investments in the new equipment only if they perceive the technology to be sound, reliable, progressive, and cost effective (including system management and supervision costs). Operators will strive to solve operating bottlenecks, fine tune performance or follow prudent maintenance practises only if they are interested, and freely committed to successful performance. Positive attitudes represent a supportive environment to embrace wood burning technology. Negative attitudes represent constraints, to be addressed through information transfer and other means.

The attitudes of owners and operators at the various sites were gleaned from conversations during site visitations to gather physical site parameters and fuel records. The owners and operators were not specifically told their feelings would be recorded, and they may in fact disagree with the perceptions absorbed by the consultant.

The perceived attitudes of the various building owners and operators are summarized in this section. In aggregate, the building owner attitudes were neutral to positive toward installing individual wood heating units to heat their building. A centralized heating plant that operated reliably, provided them cost savings, and if supervised by "someone else", was generally preferred. Operator attitudes generally varied from negative to "luke warm" to the prospect of operating wood heating equipment. The general conclusions drawn from this exercise are as follows:

a) Centrally located multi-customer heating plants are preferred since operating and maintenance issues remain the responsibility of the central plant operator.

b) Private building owners are interested in wood heating technology, are anxious to save money, but do not have large investment funds available.

c) Government owners are prepared to adopt wood heating technology, but primarily at the initiative of a private entrepreneur.

d) The negative attitudes found in some building operations and maintenance staff can probably be overcome through education on the capabilities and modern features of current wood burning systems.

e) Owners generally prefer to retain their existing oil fired heating equipment, as "insurance", for stand-by service to back up a wood heating plant.

3.2 PERCEIVED OWNER ATTITUDES

3.2.1 Proposed New Federal Building

The proposed new federal building has Public Works Canada Northern Region (Edmonton Office) as the technical and design authority. Day to day operational responsibility for the building will be vested with the local Fort Smith DPW-Canada maintenance staff. Initiatives by the Fitz Smith Native Development Corporation Ltd. to have the building heated by wood fuel, either by a dedicated plant or by a central plant, are best directed jointly to the Minister for DIAND and the Minister for Public Works Canada. DIAND's interests are motivated on community economic development grounds; Public Works on technical viability and economic cost saving. Contact with the Minister's office, DIAND, has met with very positive support for a concept to heat the building with wood fuel. This contact has been on going since mid-1983. DIAND apparently specifically requested DPW-Canada to examine the technical feasibility of the concept. Public Works reaction to this request is unknown. However, Public Works were specifically approached by the Development Corporation directly. A tentative, but somewhat encouraging response was obtained in the form of a letter, enclosed overleaf. Recent contact with Mr. D.W Wilson has reaffirmed the willingness of DPW to recommend adoption of externally supplied heat energy on technical grounds. The physical requirements to tie-in an external heat supply are recognized as simple. The tentative support was based on considering heat from a central heating site. Adoption of a dedicated wood fired heating system, operated by local DPW-Canada maintenance staff would require further Public Works internal consultation.

Public Works Canada | Travaux publics Canada

Western Region | Région de l'Ouest

16 September, 1983

Our File:
4355-F33/12

Manecon Partnership
Mañagement and Economic Consultants
415 Revillon Building
10201 - 104 Street
Edmonton, Alberta
T5J 1B2

Attention: Mr. R.S. Brommeland, P. Eng.

Dear Sir:

Re: Fort Smith, North West Territories
Planned Federal Building

Thank you for your August 30, letter describing a proposed woodburning district heating system that could include the Federal Building which is recently being designed.

Our present schedule for construction is that the building will require heat during the winter of 1984/85. We have, therefore, decided to proceed including an independant heating system in the building.

At a later date, in the event that heat becomes available from the district system at an economical rate we will give careful consideration to becoming user with the original in-house plant relegated to standby.

I trust this interim response to your proposal is acceptable.

Yours very truly,

D.W. Wilson
Manager Mechanical Engineering
Building Resources
Design & Construction
Western Region
420-3164

3rd

P.O. Box 488
9925 – 109th Street
Edmonton, Alberta
T5J 2K1

B.P. 488
9925 – 109ième rue
Edmonton (Alberta)
T5J 2K1

S/st/D1-1

Canada

3.2.2 RCMP Detachment Office

A decision to adopt wood burning technology at the RCMP detachment office would involve, to a significant extent, the Yellowknife regional manager of assets and property, the regional chief inspector, and the detachment commanding officer. Technical questions would be deferred to Public Works Canada engineering staff.

The initial reactions to the concept of stand alone or dedicated wood heating equipment were clearly negative. Reactions to the idea of receiving heat supplied from a central heating plant were indifferent.

The regional chief inspector indicated that funds to finance any conversion to wood fuel would have to come from internal government office incentive programs, such as those previously offered by EMR-Canada. Additionally, the approval and technology would have to be recommended as sound and reliable by EMR and the appropriate government departments knowledgeable in these technologies. It was conceded that if cost savings and operating reliability could be demonstrated, and if the existing oil fired equipment could be configured for stand-by service and automatic start-up, a centrally created external heat supply would be seriously considered.

The fundamental concern expressed by all RCMP contacts was that the detachment is not well positioned to deal with a heating system that requires any significant supervision, manual operation or technical skills. The detachment officers are out of the office frequently, are posted to new communities frequently, and shift by shift responsibilities do not include consideration for building mechanical functions. The constables are obviously hired and trained as peace officers and not as wood handlers or boiler operators. Consequently, any wood fuel based alternative advanced must meet the following criteria for acceptance:

- economically superior to fuel oil
- technically reliable
- automatic operation and unattended operation for days at a time.
- automatic switch over to a stand-by fuel oil based heating system.
- adequate wood fuel supply and delivery is assured.

3.2.3 GNWT Regional Headquarters Building

The regional headquarters building is owned by the GNWT and operated by the GNWT Department of Public Works Fort Smith Area Maintenance Office. Technical considerations to proposed changes in the building heating systems would be ruled upon by the Regional Engineer DPW, located in Fort Smith. Cost and political considerations are more likely the domain of the Regional Director and, in turn, the GNWT elected Executive Council, including the GNWT Ministers responsible for Public Works, Economic Development and all relevant departments.

Substantial positive support exists within the GNWT Regional Office and at the ministerial level, for the adoption of wood fuelled heating technology. The Regional Director , Regional Engineer's office and the Minister's (DPW) Office have gone on record as conditionally supporting the purchase of heat energy from an external private utility company (note the letters overleaf). Discussions are on-going with the GNWT to sell heat energy to schools in the community from a privately owned central wood boiler heating plant. Without the impetus of an external entrepreneur however, it is speculated that the GNWT would take no initiatives to convert to wood fuelled heating.

Northwest
Territories Minister of Public Works

[illegible] 2 1983

Dan MacDonald,
Fitz-Smith Native Development Corporation,
Box 89,
Fort Smith, N.W.T.
X0E 0R0

Dear Mr. MacDonald,

Further to your proposal to construct a central wood boiler facility to provide steam heat to four government buildings in Fort Smith, the Department of Public Works is prepared to purchase such heat, at a price competitive with oil-fired heat, subject to the availability of suitable staff to operate and maintain the wood-fired boiler systems, and subject to a heat sales agreement structured so that both parties benefit from efficient operation and maintenance of the system.

Further to your meeting with our staff, July 11 in Fort Smith, another meeting is planned with Manecon Consulting Partnership in the near future to critically examine the information prepared to date, to ensure that all of our technical concerns are made known in order that they are properly addressed in the subsequent development of a detailed design. The purpose of this design, as you are aware, is to ensure that all capital and operating costs relating to this proposal are known and accurate.

Yours sincerely,

Arnold J. McCallum,
Minister.

Government of the Northwest Territories, Yellowknife, N.W.T. Canada X1A 2L9 / Telex: 034-45538 / Tel. (403) 873-7658

The constraints placed by the GNWT on the adoption of wood heating technology are:

- wood fuel based heating must cost the same as or less than oil based heating.
- existing oil fired equipment must be retained for back-up service.
- wood burning plant must be technically sound and operationally viable.

3.2.4 **Winerack Building**

The Winerack office and restaurant building is owned and operated by a Fort Smith resident business person. The owner is open minded about the prospect of heating the building from wood fuel. Any concept proposed must:

- be economically superior to the use of electricity for heating including the cost of operations, maintenance and supervision.
- demonstrate a secure supply arrangement for wood fuel.
- offer a quick return on investment.
- retain the existing heating system for back-up service.

A central heating plant concept is preferred since responsibilities for wood fuel supply, equipment supervision, etc. rest with "someone else."

3.2.5 Pelican Rapids Inn

The Pelican Rapids Inn motel is owned jointly by a Hay River motel operator and a partner in Alberta. The non-resident owners have delegated day to day responsibilities to a husband/wife resident manager team. The managers would prefer a concept with heat supplied from a central source, rather than assume additional responsibility for the operation and supervision of a wood boiler.

The owners were quite open minded about the prospect of wood fuel based heating. Predictably, the owners are keen to reduce operating costs, as possible, and would seriously consider a concept that offered cost savings. The owners would seek a relatively short payback (5 years or less) on their investment in wood burning technology. They would prefer an approach that placed no major extra load on the resident managers.

The owners are planning (at some uncertain future date) the construction of a restaurant on the adjacent property to the east of the motel. It was suggested that, if a stand alone wood boiler system was most viable, it could be incorporated into the restaurant building, with heat supplied over to the motel building.

3.2.6 Pinecrest Hotel

The Pinecrest is owned by two non-resident partners, and operated by a hotel resident manager. All three individuals are receptive to stand alone conversion to wood heating, or to the purchase of heat from an external supply source. The owners have made previous enquiries about wood burning systems and have followed the performance of the Town of Fort Smith wood fuelled system for the water treatment plant.

The owners are comfortable with the reliability of the technology and are primarily motivated by the operating cost savings potentially possible. The owners do not have a significant amount of capital to invest in a stand alone wood burning boiler installation and would hope to finance a system significantly from government grants. The constraints imposed upon the acceptance of wood burning technology are:

- capital investment would have to be recovered in 5 years or less from incremental savings in fuel and operating costs.
- existing boiler equipment would be retained for back-up service.
- the system would have to be automated enough to minimize supervision to just a few minutes per day.

The owners would be most interested in the purchase of heat from a central source, if viable, due to the reduced responsibility they would carry for fuel supply, supervision, etc.

3.2.7 Hudson's Bay Store

A decision to adopt wood burning technology would be made in consultation among the Fort Smith Store Manager, the regional superintendent in Winnipeg, Manitoba and the Bay technical support staff also in Winnipeg.

The regional superintendent indicated that a concept proposed to the Bay for the purchase of heat from an external source or the erection of a dedicated wood fuelled heating system would be given an honest and serious evaluation by the regional office. The economic viability of the proposal would be of primary importance. The impact on the responsibilities of the resident staff would also be a consideration. The local assistant manager was not supportive of a wood fuelled heating concept generally. Concerns were expressed about the longevity of regional wood fuel resources, security of supply from local wood fuel cutters, increased administration effort, equipment reliability, the need and security for a fuel stock pile on site, etc. Clearly, a concept in which the operating and maintenance responsibilities are retained by an independent heat energy vendor is preferred by the resident manager.

3.2.8 Airport Buildings

A decision to adopt a wood heating system for one or more of the Department of Transport buildings at the Fort Smith Airport would be made in consultation among the Airport Manager, Regional Superintendent of Airport Facilities, and regional technical staff, located in Edmonton. The present effort to consider wood fuel for heating is derived from the interest and initiative of the present Airport Manager. Regional authorities have not been briefed in detail on the concept. The MOT procedure to initiate a change in the heating regime is for the Airport Manager to submit a P.I.D. (Project Initiation Document) outlining the proposed project, the total capital cost, operating and maintenance cost changes, incremental man years, and proposed schedule.

The proposed physical changes will be required to meet Transport Canada standards including standards for types of materials, design lifetime, exterior building finishes, height restrictions (in certain locations), etc. The standards are reportedly reasonable ones and simply ensure safety and aesthetic continuity.

The Airport Manager is clearly supportive of a concept to supply wood heat to selected Transport Canada buildings, if economically viable. The present Airport Manager is expecting a transfer in the next six months, however, and may not be around to see a viable project come to reality.

The present oil fired facilities are maintained by the Transport Canada maintenance staff on site. The maintenance supervisor was not excited about the prospect of having to operate and maintain a wood boiler plant. However, he confessed that he did not know the responsibilities and operating requirements for modern wood fuelled heating systems.

4.0 WOOD HEATING SYSTEM EQUIPMENT

The economic viability of individual building wood fired heating systems is assessed in Chapter 5 based upon equipment and configurations described in the following paragraphs. The equipment identified is considered suitable for the applications based upon the review of product literature from a variety of known systems and components, and upon contact with suppliers. However, inclusion here is not meant to exclusively endorse the products.

All systems are configured to use chipped wood fuel as opposed to round wood. All systems are equipped with automated fuel stokers and fuel silos to permit basically unattended system operations.

It is assumed that each building owner will negotiate a wood fuel supply contract with a local contractor, (equivalent to a fuel oil supply contract) to deliver chip fuel into the building's chip storage bin at appropriate intervals.

The **wood boilers** selected represent two series of boilers manufactured by Robert Bell Industries Limited (Seaforth, Ontario). Boilers chosen for the large buildings (20 b.h.p or larger capacities) are the Robert Bell three pass "Compact" line of boilers. Similar boilers chosen for the smaller loads are the Robert Bell "Dual Pak Series II" line. Brochures on these units are enclosed in this section.

Chip fuel feeding systems consist of three major elements: a chip storage bin, a bin outfeeding unit to remove chips from the bin, and a stoker to deliver outfed material into the combustion area of the boiler. A Northfab Systems Ltd. (Stratford Ontario) feed system is selected for use with the large Bell fire box series wood boilers. A number of these units are in operation in Canada. The small Dual Pak Series II boilers have not previously been integrated with a Northfab fuel system, but can be integrated, according to the supplier. A Justsen feed system, supplied by LEC Contractors Ltd., Winnipeg, Manitoba is considered as a suitable alternate to the Northfab equipment. Brochure materials on these feed systems are included in this section.

In most cases, a new building is suggested as the housing for the additional boiler equipment. A pre-engineered steel building, manufactured by Ronaco Industries Ltd., Calgary, Alberta, is a suitable choice for these applications. The self-framing style building features a pre-painted 22 gauge steel exterior, 24 gauge fluted aluminum interior liner and fiberglas thermal insulation installed to a thickness equivalent to R20. The building is erected on a concrete foundation, prepared on site. A brochure on the Ronaco building is enclosed.

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Low Pressure

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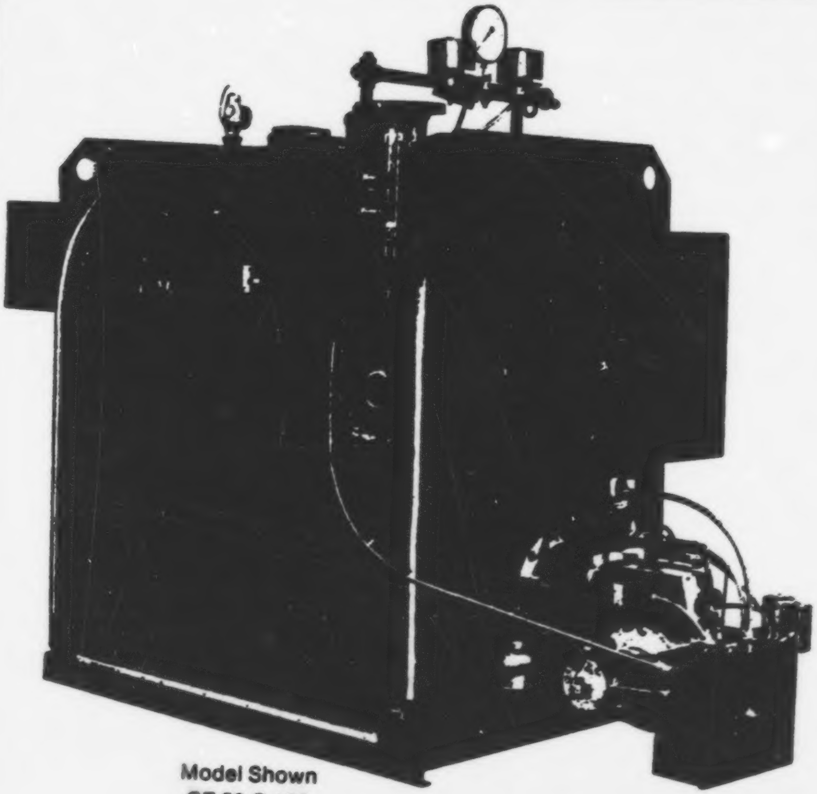

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Our Compak Series boilers are fully automatic and are adaptable to installations where floor area is at a minimum. These boilers are designed for efficient burning of oil, gas or oil and gas. All units are equipped with forced draft burners for the most efficient burning of the fuel and require stacks only for venting of spent gases, without induced draft fans or assist from oversized chimneys. The efficiency of these boilers compares favourably with other types of generators on the market, including two, three and four pass Scotch, watertube and coiled tube designs.

These boilers can be supplied with an optional high base that makes future conversion to solid fuels simple.

Easy to Install and Service

Compak packaged boilers provide easy access to all firing surfaces for cleaning and inspection.

Ample openings are provided for internal waterside inspection of the boiler.

The front smokebox door is easily removed for the inspection and cleaning of the tubes. The smokeboxes are of heavy 10 ga or 3/16 inch thick steel.

The Compak Series boiler is shipped completely assembled and factory test-fired requiring only connections to steam, water, fuel and power lines.

Engineered to Last

The Compak series boilers have been designed specifically for gas and oil firing and offer exceptional durability, ruggedness and proven long life.

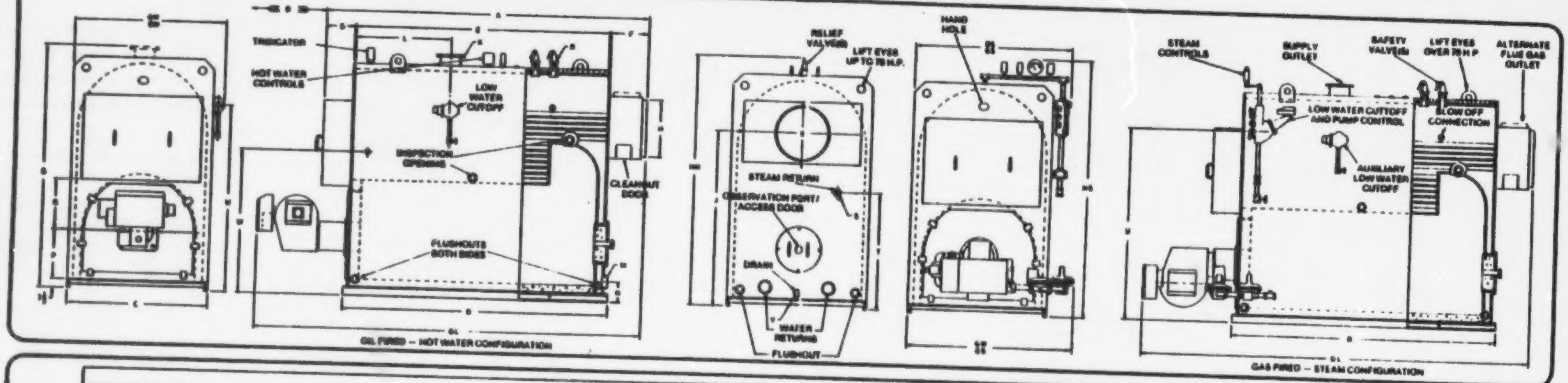
Design features include:

- 3 Pass full wet back design for maximum efficiency.
- 5 square feet of heat transfer surface per boiler horse power.
- Generous furnace volume with resulting conservative heat release.
- Large steam space and steam release area.
- No possibility of short circuiting between tube passes as in dry back designs.
- Minimum refractory. Maintenance and replacement of floor or door refractory is fast and simple.
- Extra heavy construction.
- Adaptable to many makes of conversion type burners.
- Large primary heat transfer surface reduces stress on tube sheets.

EFFICIENCY 80% PLUS
LOW STACK TEMPERATURE
EASY TO OPERATE
EASY TO SERVICE
EASY TO CLEAN

SAVE WITH THE
COMPAK SERIES
FIREBOX
BOILERS

15# STEAM BELL COMPAK SERIES 30# WATER



OIL FIRED — HOT WATER CONFIGURATION

GAS FIRED — STEAM CONFIGURATION

COMPACT SERIES SPECIFICATIONS

HORSE POWER		9	10	15	18	20	25	30	35	40
GROSS OUTPUT	MBH	302	335	503	603	670	838	1005	1173	1340
FIRING RATE INPUT GAS	MBH	377	419	629	754	838	1048	1256	1466	1675
FIRING RATE INPUT OIL	USGPH	2.40	2.90	4.49	5.39	5.90	7.49	8.97	10.5	12.0
GROSS STEAM EDR	SQ FT	1256	1395	2093	2512	2791	3488	4170	4792	5650
GROSS WATER EDR	SQ FT	2010	2233	3350	4020	4466	5583	6700	7667	8933
HEATING SURFACE	SQ FT	53	53	77	90	98	123	153	171	206
FURNACE VOLUME	CU FT	9.2	9.2	9.0	11.3	11.3	13.9	21.2	23.6	26.4
WATER CAPACITY FULL	IMP GAL	73	73	85	113	113	145	172	196	225
WATER CAPACITY NWL	IMP GAL	57	57	65	87	87	112	134	153	176
SHIPPING WEIGHT	LBS	1600	1600	1850	2250	2250	2650	3000	3900	4200
ALL DIMENSIONS TO THE NEAREST INCH										
A	BARE BOILER LENGTH	51	51	52	63	63	74	73	80	88
B	BARE BOILER HEIGHT	54	54	57	57	57	57	70	70	70
C	BARE BOILER WIDTH	34	34	34	34	34	34	39	38	38
D	BASE LENGTH	35	35	36	46	46	57	53	60	68
E	SHELL LENGTH	32	32	33	43	43	54	50	57	65
F	REAR SMOKEBOX DEPTH	11	11	11	12	12	12	16	16	16
G	FRONT SMOKEBOX DEPTH	7	7	7	7	7	7	8	8	8
H	SMOKE OUTLET DIAMETER	6	6	6	6	6	6	10	10	10
J	SMOKE OUTLET LOCATION	41	41	42	42	42	42	52	52	52
K	SUPPLY SIZE	3	3	4	4	4	4	4	4	6
L	SUPPLY LOCATION	16	16	16	16	16	16	24	24	24
M	RETURN SIZE (WATER)	3	3	4	4	4	4	4	4	4
N	RETURN LOCATION (WATER)	7	7	7	7	7	7	8	8	8
O	TUBE REMOVAL	26	26	27	37	37	48	44	50	58
P	FURNACE CENTRELINE	12	12	10	10	10	10	12	12	12
Q	FURNACE CL TO SMOKEBOX	12	12	11	12	12	12	15	15	15
R	SAFETY RELIEF SIZE	1	1	1.5	1.5	1.5	1.5	2,2	2,2	2,2
S	RETURN SIZE (STEAM)	1	1	1	1	1	1	1	1	1
T	RETURN LOCATION (STEAM)	27	27	27	27	27	27	32	32	32
U	NORMAL WATER LINE HEIGHT	40	40	43	43	43	43	51	51	51
V	DRAIN SIZE	1.25	1.25	1.5	1.5	1.5	1.5	2	2	2
W	LWCO LOCATION	23	23	28	28	28	28	33	33	33
[illegible]	OVERALL HEIGHT HOT WATER	50	50	63	63	63	63	75	75	76
[illegible]	OVERALL HEIGHT STEAM	57	57	66	66	66	66	76	76	76
[illegible]	OVERALL WIDTH HOT WATER/OIL	30	30	40	40	40	40	45	45	45
[illegible]	OVERALL WIDTH STEAM/OIL	41	41	42	42	42	42	47	47	47
[illegible]	OVERALL WIDTH HOT WATER/GAS	30	30	40	40	42	42	48	48	48
[illegible]	OVERALL WIDTH STEAM/GAS	41	41	42	42	42	42	48	48	48
[illegible]	OVERALL LENGTH	63	63	63	74	63	74	93	100	100

HORSE POWER		45	50	60	70	80	100	125	150	175
GROSS OUTPUT	MBH	1508	1675	2010	2345	2680	3350	4188	5025	5863
FIRING RATE INPUT GAS	MBH	1885	2094	2512	2931	3350	4188	5235	6281	7329
FIRING RATE INPUT OIL	USGPH	13.5	15.0	18.0	20.9	23.9	29.9	37.4	44.9	52.4
GROSS STEAM EDR	SQ FT	6430	7292	8542	9781	11062	13960	17430	20925	24413
GROSS WATER EDR	SQ FT	10100	11667	13667	15667	17867	22333	27813	33495	39078
HEATING SURFACE	SQ FT	225	250	300	350	400	500	625	750	875
FURNACE VOLUME	CU FT	30.3	31.3	36.0	40.8	45.9	59.2	72.4	86.5	116.0
WATER CAPACITY FULL	IMP GAL	246	237	282	327	416	515	590	714	767
WATER CAPACITY NWL	IMP GAL	193	191	227	264	312	387	460	549	595
SHIPPING WEIGHT	LBS	4600	4900	5400	5900	6300	7000	8300	9300	11600
ALL DIMENSIONS TO THE NEAREST INCH										
A	BARE BOILER LENGTH	93	87	96	105	112	132	122	139	136
B	BARE BOILER HEIGHT	70	73	73	73	80	80	80	85	100
C	BARE BOILER WIDTH	39	44	44	44	47	47	54	54	58
D	BASE LENGTH	73	64	75	85	88	106	101	118	111
E	SHELL LENGTH	70	61	72	83	85	104	97	114	107
F	REAR SMOKEBOX DEPTH	14	16	16	16	18	18	14	14	16
G	FRONT SMOKEBOX DEPTH	8	9	9	9	9	9	10	10	12
H	SMOKE OUTLET DIAMETER	10	12	12	12	14	14	18	18	24
J	SMOKE OUTLET LOCATION	52	54	54	54	57	57	64	64	73
K	SUPPLY SIZE	6	6	6	6	6	8	8	8	8
L	SUPPLY LOCATION	24	24	24	24	36	36	36	36	40
M	RETURN SIZE (WATER)	4	4	4	4	4	4	4,4	4,4	4,4
N	RETURN LOCATION (WATER)	8	8	8	8	8	8	8	8	8
O	TUBE REMOVAL	63	56	64	75	77	96	99	106	96
P	FURNACE CENTRELINE	12	12	12	12	16	14	15	15	21
Q	FURNACE CL TO SMOKEBOX	15	17	17	17	16	18	22	22	22
R	SAFETY RELIEF SIZE	2,2	2,2	2,2	2,2	2,2.5	2,2.5	2.5,2.5	2.5,2.5	2.5,2.5
S	RETURN SIZE (STEAM)	1	1	2	2	2	2	2	2	2
T	RETURN LOCATION (STEAM)	32	33	33	33	36	36	42	42	37
U	NORMAL WATER LINE HEIGHT	51	54	54	54	57	57	67	67	78
V	DRAIN SIZE	2	2	2	2	2	2	2	2	2
W	LWCO LOCATION	33	41	41	41	43	43	47	47	65
[illegible]	OVERALL HEIGHT HOT WATER	76	78	78	78	85	88	98	98	107
[illegible]	OVERALL HEIGHT STEAM	76	81	81	81	87	87	100	100	112
[illegible]	OVERALL WIDTH HOT WATER/OIL	45	49	49	49	54	54	59	59	65
[illegible]	OVERALL WIDTH STEAM/OIL	47	51	51	51	56	56	61	61	67
[illegible]	OVERALL WIDTH HOT WATER/GAS	48	55	55	55	63	63	69	69	74
[illegible]	OVERALL WIDTH STEAM/GAS	48	55	55	55	63	63	69	69	74
[illegible]	OVERALL LENGTH	114	109	116	132	137	156	167	166	164

HORSE POWER		200	225	250	250	275	300	320	320	340	360	380	400	440
GROSS OUTPUT	MBH	6700	7538	8375	8375	9213	10050	10720	10720	11390	12060	12730	13400	14740
FIRING RATE INPUT GAS	MBH	8375	9423	10469	10469	11516	12563	13400	13400	14238	15075	15913	16750	18425
FIRING RATE INPUT OIL	USGPH	59.8	67.3	74.8	74.8	82.3	89.7	95.7	95.7	101.7	107.7	113.7	119.6	132.0
GROSS STEAM EDR	SQ FT	27900	31390	34885	34885	38366	41853	44644	44644	47434	50244	53036	55804	61385
GROSS WATER EDR	SQ FT	44660	50246	55800	55800	61409	66981	71457	71457	75923	80389	84855	89322	98254
HEATING SURFACE	SQ FT	1000	1125	1250	1250	1375	1500	1600	1600	1700	1800	1900	2000	2200
FURNACE VOLUME	CU FT	127.3	155.4	180.0	170.0	191.0	207.7	218.7	240.5	253.0	265.4	277.8	290.3	315.1
WATER CAPACITY FULL	IMP GAL	865	1130	1252	1126	1223	1330	1418	1370	1448	1527	1606	1685	1842
WATER CAPACITY NWL	IMP GAL	661	856	970	854	928	1017	1070	1050	1110	1172	1233	1294	1415
SHIPPING WEIGHT	LBS	12950	14050	17500	16500	17500	18000	19500	20100	20750	21700	22600	23400	25100
ALL DIMENSIONS TO THE NEAREST INCH														
A	BARE BOILER LENGTH	149	128	140	133	142	150	156	165	151	157	163	160	181
B	BARE BOILER HEIGHT	100	110	110	129	129	129	129	135	135	135	135	135	135
C	BARE BOILER WIDTH	58	66	66	75	75	75	75	81	81	81	81	81	81
D	BASE LENGTH	124	113	124	101	109	119	125	113	109	125	131	137	149
E	SHELL LENGTH	120	109	120	96	104	114	120	100	116	120	126	132	144
F	REAR SMOKEBOX DEPTH	16	16	16	20	19	20	20	22	22	22	22	22	27
G	FRONT SMOKEBOX DEPTH	12	12	12	14	14	14	14	16	14	14	14	14	14
H	SMOKE OUTLET DIAMETER	24	24	24	30	30	30	30	30	30	30	36	36	36
J	SMOKE OUTLET LOCATION	72	86	86	97	97	92	92	98	98	98	98	98	98
K	SUPPLY SIZE	8	8	8	8	8	10	10	10	10	10	10	10	10
L	SUPPLY LOCATION	40	40	40	40	40	40	40	34	34	41	42	42	46
M	RETURN SIZE (WATER)	4,4	8,8	8,8	8,8	8,8	10,10	10,10	10,10	10,10	10,10	10,10	10,10	10,10
N	RETURN LOCATION (WATER)	8	10	10	10	10	12	12	12	12	12	12	12	12
O	TUBE REMOVAL	100	97	100	97	97	100	106	94	100	105	112	110	120
P	FURNACE CENTRELINE	21	23	23	22	22	22	22	24	26	24	24	26	26
Q	FURNACE CL TO SMOKEBOX	22	22	22	24	24	24	26	27	27	27	27	27	27
R	SAFETY RELIEF SIZE	2.5,2.5	3,3	3,3	3,3	3,3	3,3	3,3	3,3	3,3	3,3	3,3	3,3	3,3
S	RETURN SIZE (STEAM)	2	2.5	2.5	2.5	2.5	2.5	2.5	3	3	3	3	3	3
T	RETURN LOCATION (STEAM)	37	56	56	66	66	66	66	72	72	72	72	72	72
U	NORMAL WATER LINE HEIGHT	78	91	91	90	90	90	90	104	104	104	104	104	104
V	DRAIN SIZE	2	2	2	2	2	2	2	2	2	2	2	2	2
W	LWCO LOCATION	65	77	77	65	65	65	65	71	71	71	71	71	71
[illegible]	OVERALL HEIGHT HOT WATER	110	127	127	136	136	136	136	141	141	161	161	161	161
[illegible]	OVERALL HEIGHT STEAM	112	129	129	137	137	137	137	142	142	142	142	142	142
[illegible]	OVERALL WIDTH HOT WATER/OIL	65	74	74	80	80	80	80	87	87	87	87	87	87
[illegible]	OVERALL WIDTH STEAM/OIL	67	78	78	83	83	83	83	89	89	89	89	89	89
[illegible]	OVERALL WIDTH HOT WATER/GAS	76	◇	◇	◇	◇	◇	◇	◇	◇	◇	◇	◇	◇
[illegible]	OVERALL WIDTH STEAM/GAS	76	◇	◇	◇	◇	◇	◇	◇	◇	◇	◇	◇	◇
[illegible]	OVERALL LENGTH	171	164	176	161	171	178	184	173	179	185	192	198	210

CONNECTIONS LARGER THAN 4 in ARE 150 lb FLANGES

◇ - CONSULT FACTORY

LARGER SIZES AVAILABLE UPON REQUEST

WE ASSUME NO RESPONSIBILITY FOR ERRORS IN DATA

Certified Dimensions, Specifications and Drawings on the above and on larger sizes are available on request. Metric data available on request.

Single stage firing is standard up to 30 H.P.
Two stage firing is standard over 30 H.P.
Full-modulating firing is available on all sizes.
Add 1.5 inches to dim "D" each for front or rear insulation.

STANDARD EQUIPMENT

1. 3-pass firebox boiler designed and constructed to the ASME low pressure boiler code and the requirements of the authorities of the Provinces of Canada.
2. 2" tubes, rolled, beaded and rerolled, providing maximum seal and strength. 2½" tubes on sizes over 992 sq. ft. heating surface.
3. Covered with fiberglas insulation and steel jacket with Hi-temp enamel finish. 2" insulation on sizes 400 sq. ft. heating surface and above, 1" below.
4. Insulated, gas-tight front smoke box. Davit hinges on sizes over 992 sq. ft. heating surface.
5. Removable, gas-tight rear smoke box c/w cleanout port and optional vertical or horizontal flue gas outlet.
6. Refractory filled, reinforced steel base providing ease of handling.
7. Rear observation sight glass. Rear 16 in. diameter access door c/w sight glass on sizes over 45 H.P.
8. Flue brush and rod.
9. Lifting eye(s) for handling.
10. Pressure-firing burner with controls for maximum efficiency.
11. Shell handhole on sizes 50-200 H.P., 11 x 15 manhole on sizes over 200 H.P.

MADE IN CANADA   FABRIQUE AU CANADA

"ROBERT BELL MANUFACTURES
THE MOST COMPLETE LINE
OF HEATING AND POWER
BOILERS IN CANADA"

STANDARD STEAM TRIM

1. Safety Valve(s).
2. Water glass set.
3. Pressure gauge.
4. Gauge cock.
5. Syphon.
6. Try-cocks.
7. Pressuretrol — high limit safety.
8. Pressuretrol — operating.
9. Pressuretrol — high fire control on 2-stage units 30 H.P. and over.
10. M.M. 157 low-water cutoff and pump control.
11. Watts N-101S auxiliary low water cutoff control c/w blowdown valve.
12. Water column blowdown valve for MM-157.

STANDARD TRIM ON HOT WATER UNITS

1. Relief valve(s).
2. Tridicator for pressure and temperature or temp and pressure gauges on sizes over 100 H.P.
3. Watts N-501S low water cutoff.
4. Blowdown valve for low water cutoff.
5. Dual aquastat providing for operating control and high limit; single aquastat for high fire control on units 30 H.P. and over.

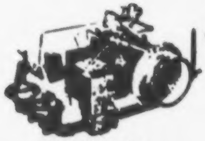
OPTIONAL EQUIPMENT

1. Opening for instantaneous or tank type coil heaters.
2. High base for future Solid fuel conversion.
3. Quick opening and Y-pattern blowdown valves.
4. OS & Y water column isolating valves.
5. Rear access door hinge.
6. Davit hinge on front tube access door on units below 1000 sq. ft. heating surface.
7. Front or rear head insulation.
8. Handhole type cleanouts.
9. Customer supplied burner.

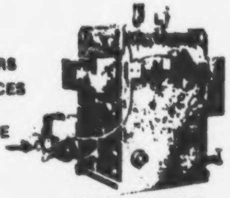
Our name is synonymous with excellence in design, quality of workmanship, durability of product and good service. *FOR BETTER BOILERS BUY "BELL".*

Your headquarters for:
Custom Boilers and Pressure Vessels

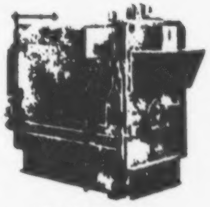
HIGH AND LOW PRESSURE BOILERS
SCOTCH, VERTICAL AND FIREBOX
HOT WATER HEATING BOILERS
COMBINATION OIL AND SOLID FUEL BOILERS
COMBINATION OIL AND SOLID FUEL FURNACES
HIGH AND LOW PRESSURE BOILERS
FOR AUTOMATICALLY FIRED WOOD WASTE
PORTABLE BOILERS
OIL BURNERS
GAS BURNERS
CONDENSATE UNITS
CONDENSATE RETURN PUMPS
BLOWDOWN TANKS
AIR RECEIVERS
BOILER AND BURNER CONTROLS
SOLID FUEL ONLY BOILERS
SOLID FUEL ONLY FURNACES
GRAVITY FLOW FURNACES



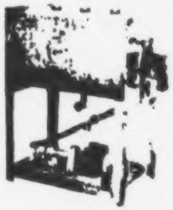
POWER GAS BURNERS
212,000 TO 7,400,000 BTU/HR INPUT



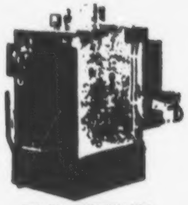
3 PASS COMPACT BOILERS
GAS FIRED OR OIL FIRED
5 H.P. TO 15 H.P.



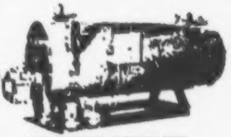
DUAL PAK COMBINATION
SOLID FUEL/OIL BOILERS
120,000 BTU/HR TO
1,000,000 BTU/HR OUTPUT



CONDENSATE UNITS
10 H.P. TO 600 H.P.
15 P.S.I.G. TO 200 P.S.I.G.

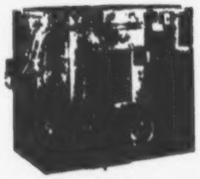


DUAL PAK 2.5 COMBINATION
SOLID FUEL-OIL BOILERS
TO 125,000 BTU/HR OUTPUT



HI PRESSURE STEAM GENERATORS
GAS FIRED OR OIL FIRED
3 H.P. TO 600 H.P.

AUTOMATIC WOOD WASTE
FIRED FIREBOX BOILERS
HIGH OR LOW PRESSURE
UP TO 600 H.P.



DUAL AIRE COMBINATION
SOLID FUEL/OIL FURNACES
100,000 TO 500,000 BTU/HR OUTPUT

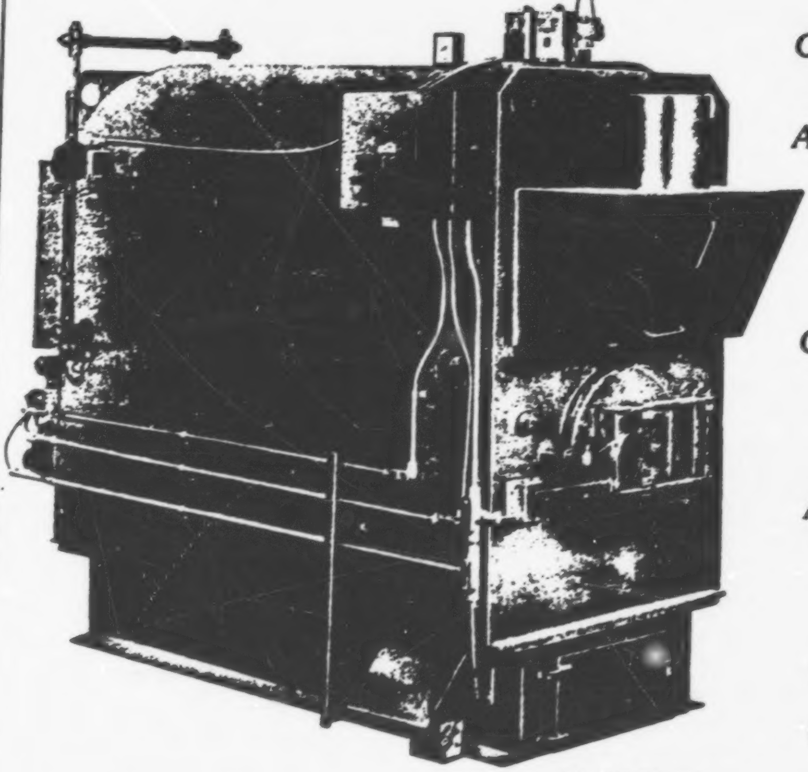
Syncro

COMBINATION OIL AND SOLID FUEL

DUAL - PAK SERIES II

Boilers

Boilers built in Canada by Robt. Bell Industries Ltd., an All-Canadian Company with over 80 years Boiler Building experience



Model Shown
DUK-24-OW-30W
Standard Finish

ALSO AVAILABLE AS SOLID FUEL ONLY UNITS

Boilers
Designed
to
Combat High Energy Costs

Avoid Problems Caused By
Fuel Shortages
or Power Failures

Conserve Your Country's
Energy Supplies
with
Automatic Changeover
Between Fuels
for
Low Pressure Steam
or Hot Water Heating

BULLETIN No. 102 - 81

Robert Bell Industries Limited

TELEX 069-55305 — SEAFORTH, ONTARIO — 519-527-0600
P.O. BOX 70 N0K 1W0

Engineered to Last

The Dual-Pak Series boilers are a 2 Pass firebox design constructed to the ASME low pressure boiler code and the requirements of the provinces of Canada.

Two and one-half inch diameter boiler tubes are used allowing for low draft loss to facilitate operation with natural draft for solid fuel fires. All boiler tubes are rolled, beaded and rerolled providing for maximum in seal and strength. Boilers are designed for oil output rated at 6 or more square feet of heating surface per boiler H.P. All units are covered with fiberglas insulation and steel jacket with a Hi-Temp enamel finish. Ample openings are provided to all firing and internal surfaces for cleaning and inspection. Gas tight front and rear smoke boxes are constructed of 10 ga. steel to provide for maximum length of troublefree service. The rear somebox is insulated to prevent heat loss as well as offering protection to the smokebox.

Combustion

These units do not use so called "air tight" combustion areas and long burns since these features are the paramount culprits producing creosote. An extra large furnace volume coupled with a high temperature dry refractory lined firebox maintains high temperatures in the combustion zone enabling complete combustion. This is especially advantageous for burning fuels of higher moisture content. Cast iron grates enhance the unit's versatility in selection of solid fuels. Units are designed with an extra large grate area to ensure its rated output on solid fuel firing. Combination units come equipped with forced draft burners for the economic burning of light oil. Oil and wood are fired in the same combustion zone to facilitate ignition of most solid fuels. An automatic under the fire damper ensures that an adequate supply of combustion air is provided to facilitate complete combustion of solid fuels.

Fully Automatic

All Dual-Pak Series packaged firebox boilers are fully automatic. Since oil and wood are fired in the same combustion zone, oil may be used to ignite most solid fuels, avoiding the tedious procedure of kindling solid fuel fires. The control system governs four separate operations controlled by a 3-way selector switch on the control panel and a manual timer.

OPERATING MODES

1. OIL ONLY AS FUEL

2. WOOD OR SOLID FUELS ONLY

3. AUTOMATIC: A constant temperature is maintained at all times. Oil automatically takes over when solid fuels burn out.

4. OIL IGNITION DELAY: Locks out oil burner on occasions when ample solid fuel has been added but fire is not fully established — saves additional oil.

The automatic below the fire damper opens and closes as the need for more heat arises when solid fuel firing. As a safety precaution the auto damper closes prior to any times the oil burner operates.

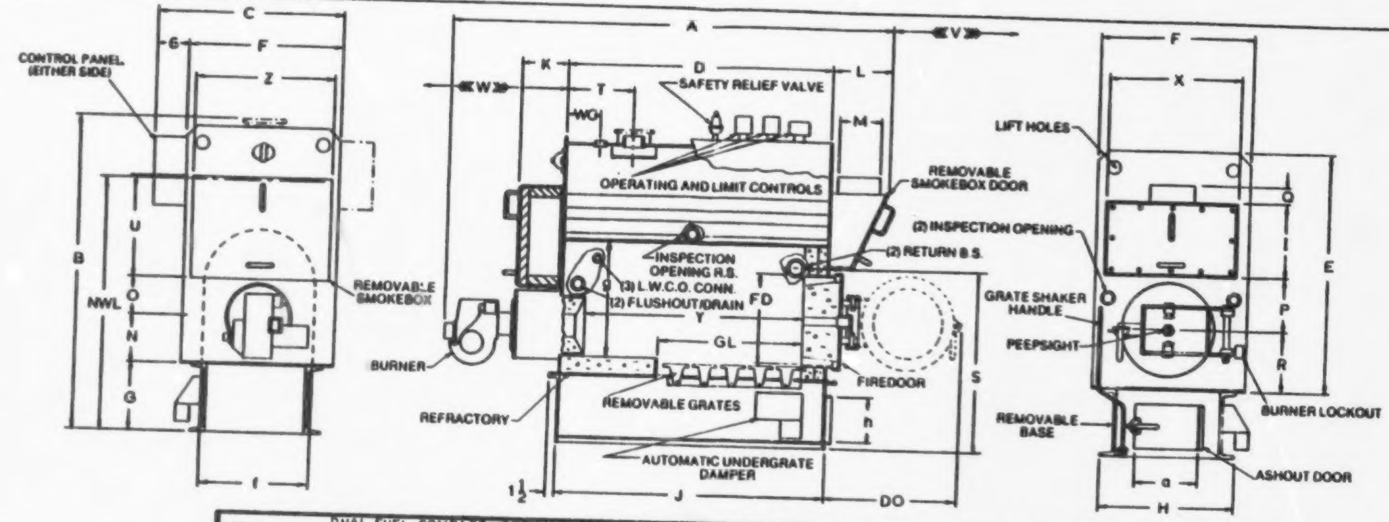
A fire door safety switch is provided to shut the oil burner off when the fire door is opened.

EASY TO OPERATE

EASY TO SERVICE

EASY TO CLEAN

SAVE WITH THE DUAL-PAK SERIES FIREBOX BOILERS


C
G
F
Z
CONTROL PANEL (EITHER SIDE)
B
U
NWL
O
N
G
f
REMOVABLE SMOKEBOX
A
V
D
K
L
W
T
WO
M
SAFETY RELIEF VALVE
OPERATING AND LIMIT CONTROLS
REMOVABLE SMOKEBOX DOOR
(2) RETURN B.S.
INSPECTION OPENING R.S.
(3) L.W.C.O. CONN.
(2) FLUSHOUT/DRAIN
FD
Y
GL
BURNER
REFRACTORY
REMOVABLE GRATES
FIREDOOR
S
h
AUTOMATIC UNDERGRATE DAMPER
1½
J
DO
F
X
LIFT HOLES
(2) INSPECTION OPENING
E
GRATE SHAKER HANDLE
P
PEEPSIGHT
R
REMOVABLE BASE
BURNER LOCKOUT
ASHOUT DOOR
a
H

DUAL FUEL COMPACT SERIES SPECIFICATIONS (NOTE: ALL DIMENSIONS TO THE NEAREST INCH)

	NOMINAL BOILER HORSEPOWER		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	HEATING SURFACE	SQ FT	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	APPROXIMATE MAX GROSS OUTPUT SOLID FUEL & OIL	MBH	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	STEAM E.D.R. NET	SQ FT	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	WATER E.D.R. NET	SQ FT	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	STEAM OUTPUT	LBS/HR	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	FURNACE VOLUME	CU FT	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	APPROXIMATE SHIPPING WEIGHT	LBS	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	WATER CAPACITY FULL/NORMAL STEAM	GALS	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
A	OVERALL LENGTH		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
B	OVERALL HEIGHTS NOZZLE (WATER TRIM/STEAM TRIM)		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
C	OVERALL WIDTH WATER (ADD 8 FOR STEAM)		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
D	SHELL LENGTH		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
E	SHELL HEIGHT		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
F	SHELL WIDTH		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
G	BASE HEIGHT		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
H	BASE WIDTH		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
J	BASE LENGTH		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
K	SMOKEBOX DEPTH BURNER END		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
L	SMOKEBOX DEPTH FIREDOOR END		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
M	SMOKE OUTLET DIAMETER		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
N	BURNER COMBUSTION CHAMBER CENTERLINE		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
O	COMBUSTION CHAMBER CENTERLINE TO SMOKEBOX		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
P	SMOKEBOX LOCATION FIREDOOR END		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Q	SMOKE OUTLET HEIGHT		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
R	FIREDOOR LOCATION		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
S	RETURN LOCATION		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
T	OUTLET LOCATION		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
V	TUBE REMOVAL FIREDOOR END		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
W	TUBE REMOVAL BURNER END		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Y	FURNACE LENGTH INSIDE		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	FURNACE WIDTH/FURNACE HEIGHT INSIDE		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
NWL	NORMAL WATER LINE LOCATION STEAM		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	GRATE LENGTH/WIDTH/GRATE AREA SQ FT		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SMOKEBOX HEIGHT/WIDTH FIREDOOR END		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SMOKEBOX HEIGHT/WIDTH BURNER END		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	WATER COLUMN LOCATION		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
FD	FIREDOOR OPENING DIAMETER		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	ASHOUT DOOR OPENING WIDTH/HEIGHT		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
DO	OPENED FIREDOOR		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	RETURN SIZE	CPL	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	OUTLET SIZE	CPL/FLG	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	DRAIN SIZE (NO REQD)	CPL	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	FUSE PLUG SIZE		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	CPL	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	CPL	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

NOTE: RATINGS ARE CONSERVATIVE TO ALLOW FOR VARIATIONS IN QUALITY OF SOLID FUEL AND IN FIRING PRACTICES. OIL EFFICIENCY IS OVER 80%.

Certified Dimensions, Specifications and Drawings on the above and larger sizes are available upon request.

STANDARD EQUIPMENT

1. 2 Pass firebox boiler constructed to the ASME low pressure boiler code and the requirements of the provinces of Canada.
2. 2½" boiler tubes, rolled, beaded and rerolled providing maximum seal and strength. Allows for low draft loss to facilitate operation with natural draft.
3. Oil ouput rated at 6 or more sq. ft. of heating surface per boiler H.P.
4. Covered with fibreglass insulation (R-valve of 4 per inch) and steel jacket with Hi-Temp enamel finish.
5. Gas-tight front smoke box with removable door.
6. Removable insulated gas-tight rear smokebox.
7. Dry refractory lined firebox to maintain high temperature combustion zone enhancing complete burning-especially advantageous for fuels of higher moisture content.
8. Extremely large grate area for rated output on solid fuels.
9. Fully automatic.
10. Ample openings to all firing and internal surfaces for cleaning & inspection.
11. Large furnace volume to aid in complete combustion of solid fuels.
12. Cast iron grates.
13. Oil ignition delay timer.
14. Large firedoor with positive seal.
15. Large ash door to facilitate ash removal.
16. Automatic below the fire damper.
17. Firedoor safety switch.
18. Manual timer - oil burner 5 min. to 2 hours for solid fuel ignition.
19. Flue brush and rod.
20. Overfire air system.

STANDARD TRIM ON STEAM UNITS

1. Safety Valve(s).
2. MM-42 low water cutoff and pump control.

STANDARD STEAM TRIM (continued)

3. Waterglass set.
4. Watts N-101S auxilliary low water cutoff control c/w blowdown valve.
5. Steam pressure gauge.
6. Gauge cocks.
7. Syphon.
8. Pressuretrol - operating oil.
9. Pressuretrol - operating solid fuel.
10. Pressuretrol - hi-limit both fuels.
11. Pressuretrol - hi-fire control for 2 stage oil.
12. Water column blowdown valve for MM-42.
13. Boiler blowdown and drain valve (2).

STANDARD TRIM ON HOT WATER UNITS

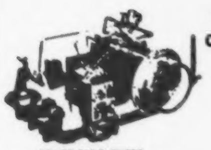
1. Relief valve.
2. Tridicator for pressure and temperature.
3. Watts N-50D low water cutoff.
4. Dual aquastat providing for solid fuel operating control and hi-limit.
5. Single aquastat providing for oil operating control and damper closure on oil firing.
6. Single aquastat - hi-fire control for 2 stage oil.
7. Blowdown valve for low water cutoff.
8. Boiler drain valve (2).

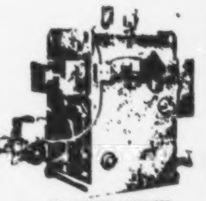
OPTIONAL EQUIPMENT

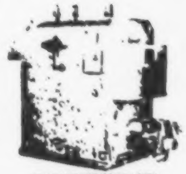
1. Opening for instantaneous or tank type coil heaters.
2. Automatic Stack Damper.
3. Elliptical Flue Brush.
4. Removable Base.
5. Draft inducer power outlet wired to operating circuit plus manual override switch.
6. Extra overfire air openings.
7. Other models available for sawdust, chips and coal only.
8. Induced draft fan system.
9. I.D. fan bypass damper.
10. Fan assist for overfire air.

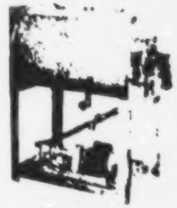
Your headquarters for:
Custom Boilers and Pressure Vessels

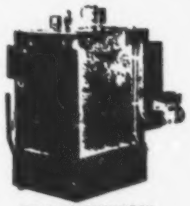
HIGH AND LOW PRESSURE BOILERS
SCOTCH, VERTICAL AND FIREBOX
HOT WATER HEATING BOILERS
COMBINATION OIL AND SOLID FUEL BOILERS
COMBINATION OIL AND SOLID FUEL FURNACES
HIGH AND LOW PRESSURE BOILERS
FOR AUTOMATICALLY FIRED WOOD WASTE
PORTABLE BOILERS
OIL BURNERS
GAS BURNERS
CONDENSATE UNITS
CONDENSATE RETURN PUMPS
BLOWDOWN TANKS
AIR RECEIVERS
BOILER AND BURNER CONTROLS
SOLID FUEL ONLY BOILERS
SOLID FUEL ONLY FURNACES
GRAVITY FLOW FURNACES

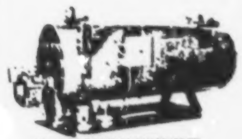

POWER GAS BURNERS
212,000 TO 7,400,000 BTU/HR INPUT

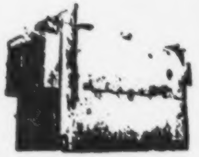

3-PASS COMPACT BOILERS
GAS FIRED OR OIL FIRED
3 H.P. TO 15 H.P.

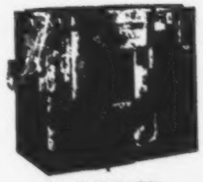

COMPACT SERIES BOILERS
3-PASS GAS FIRED OR OIL FIRED
10 H.P. TO 600 H.P.


CONDENSATE UNITS
10 H.P. TO 600 H.P.
15 P.S.I.G. TO 200 P.S.I.G.

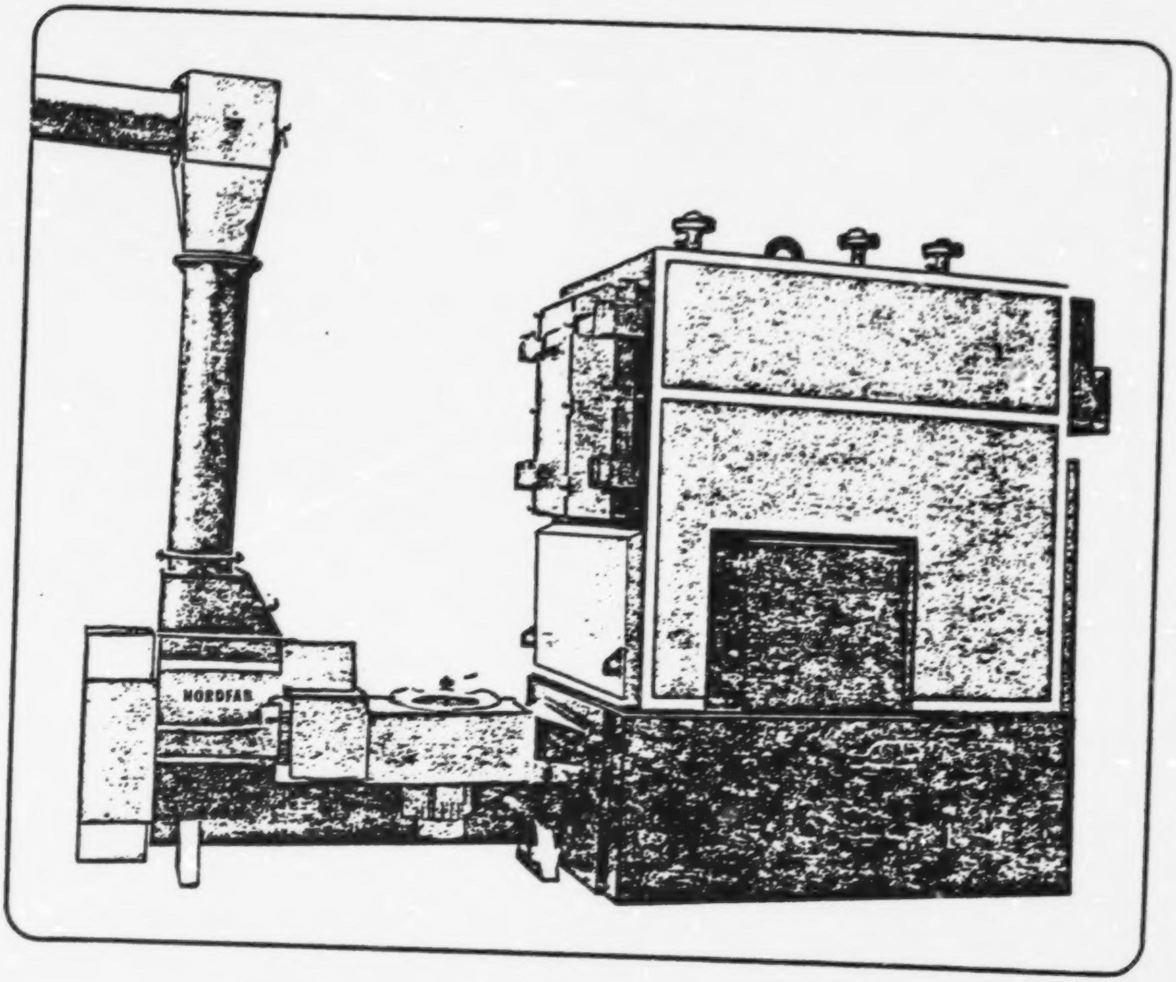

DUAL-PAK 2.5 COMBINATION
SOLID FUEL/OIL BOILERS
TO 125,000 BTU/HR OUTPUT


HI-PRESSURE STEAM GENERATORS
GAS FIRED OR OIL FIRED
3 H.P. TO 600 H.P.


AUTOMATIC WOOD WASTE
FIRED FIREBOX BOILERS
HIGH OR LOW PRESSURE
UP TO 600 H.P.


DUAL-AIRE COMBINATION
SOLID FUEL/OIL FURNACES
150,000 TO 300,000 BTU/HR OUTPUT

FULLY AUTOMATIC WOODWASTE FURNACE SYSTEM

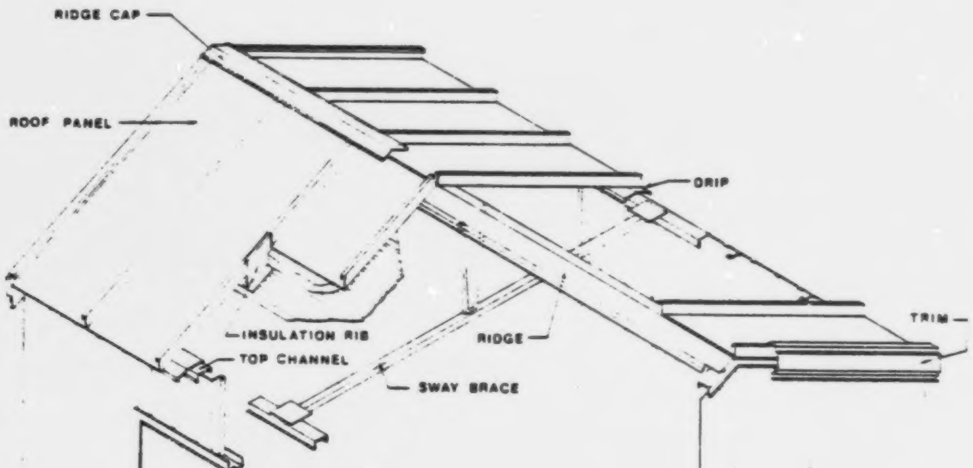


NORTHFAB
SYSTEMS, INC.

RONACO
INDUSTRIES (1977) LTD.

RONACO INDUSTRIES (1977) LTD.
Head Office: 6404 - 30th Street S.E., Calgary, Alberta T2C 1V6 — Phone (403) 279-2840
Branch Office: 3219 - 97 Street, Edmonton, Alberta T6N 1B7 — Phone (403) 463-4697

SELF FRAMING GABLE TYPE BLDG.


RIDGE CAP
ROOF PANEL
DRIP
TRIM
INSULATION RIB
RIDGE
TOP CHANNEL
SWAY BRACE
BASE FLASHING
BASE CHANNEL
INSULATION
LINER
WALL PANEL

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Branch Office: 3218 - 97 Street, Edmonton, Alberta T6N 1B7 — Phone (403) 463-4697

****** INSTALLATION INSTRUCTIONS ******

For Standard RONACO Self Framing Gable and Shed Type Metal Buildings.

FIRST - CHECK THE FOUNDATION. The Foundation from outer edge to outer edge must be the same as the overall building dimensions (width by length) and must be square, level and clean. If the Foundation is not square and level, problems with alignment of building components will occur.

NEXT - INSTALLATION OF THE BUILDING must be executed in the following order;

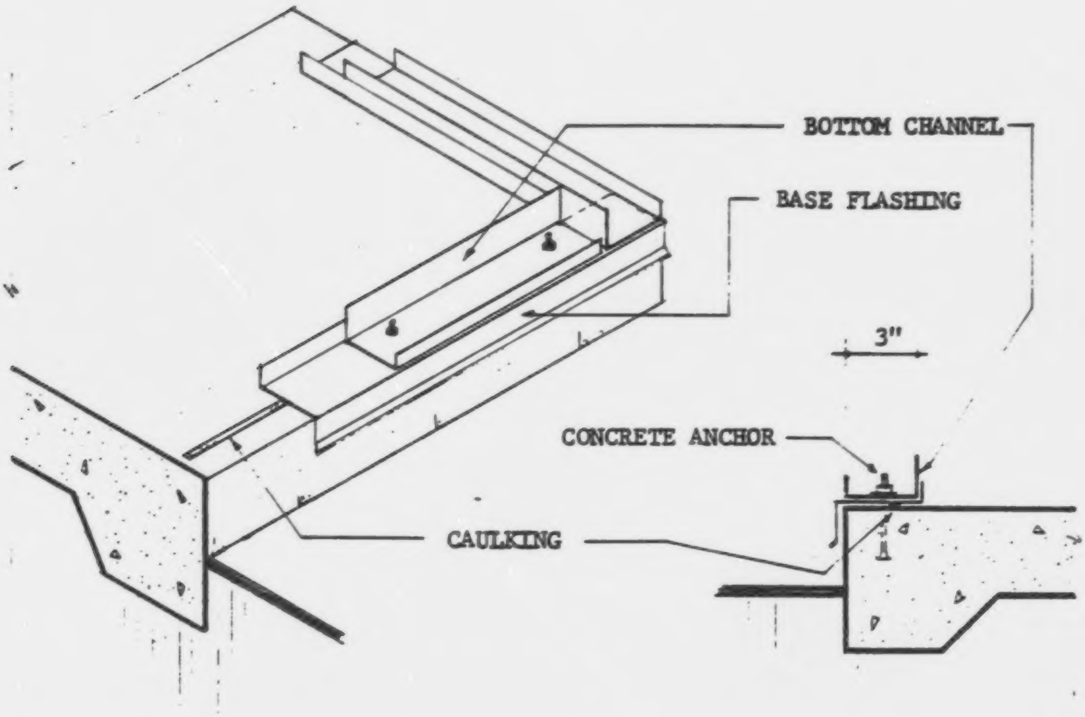
1) Base Flashing and Bottom Channel.
2) Wall Panels, Top Channel and Eave Drip.
3) Sway Braces, 'A' Frames and Ridge. (Gable Roof Only)
4) Roof Panels and Roof Trim.
5) Insulation and Liner.

NOTE: Accessories such as Man Doors, Windows and Louvers are Installed as the Building Walls are being Erected. (not Later)
Accessories such as Overhead Doors, Exhaust Fans and Eavestrough can be installed after the Building Walls and Roof have been Erected and secured.

DETAILED DESCRIPTIONS of each of the above steps complete with Drawings and Details are on the following pages.

* * *

STEP 1. INSTALLATION OF BASE FLASHING AND BOTTOM CHANNEL



STEPS:

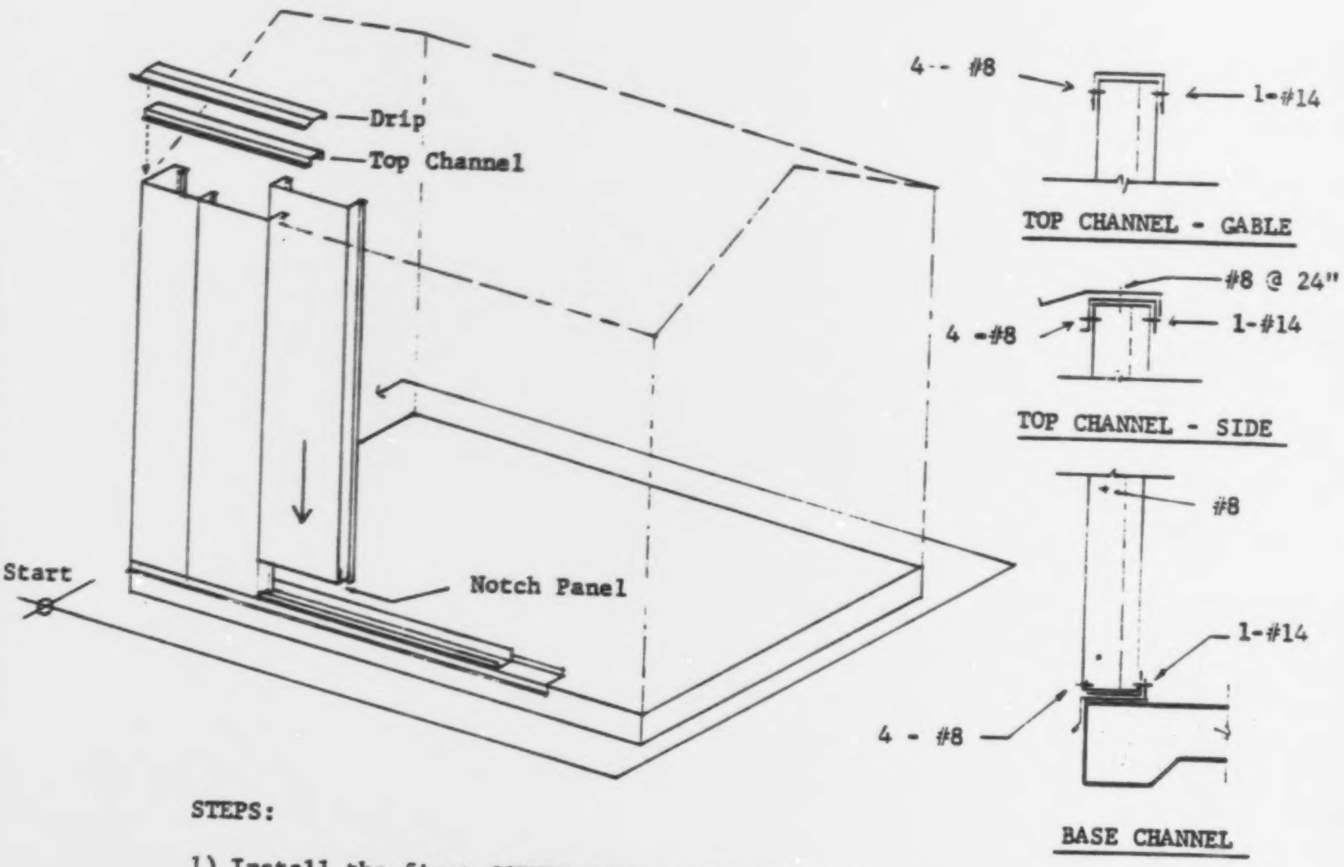
1) Clean dust and debris from outer edge of foundation.
2) Apply a heavy bead of caulking around perimeter of base 1½" in from outer edge.
3) Place BASE FLASHING and BOTTOM CHANNEL together along the outside edge of the foundation.
4) Drill holes at 20" on center thru both layers of metal and 3" into concrete.
5) Install ½" x 3" concrete anchors and tighten nuts.

NOTES:

a) BASE FLASHING must be lapped 1" at joints and must be feild mitered at building corners.
b) BOTTOM CHANNEL is placed end to end (not lapped), is notched at building corners, and is not placed below door openings.
c) Outside flange to outside flange of BOTTOM CHANNEL dimension must equal overall building dimension. (width x length)

* * *

STEP 2. INSTALLATION OF WALL PANELS, TOP CHANNEL AND EAVE DRIP.


Drip
Top Channel
Notch Panel
Start
4-- #8
1-#14
TOP CHANNEL - GABLE
#8 @ 24"
4 -#8
1-#14
TOP CHANNEL - SIDE
#8
1-#14
4 - #8
BASE CHANNEL

STEPS:

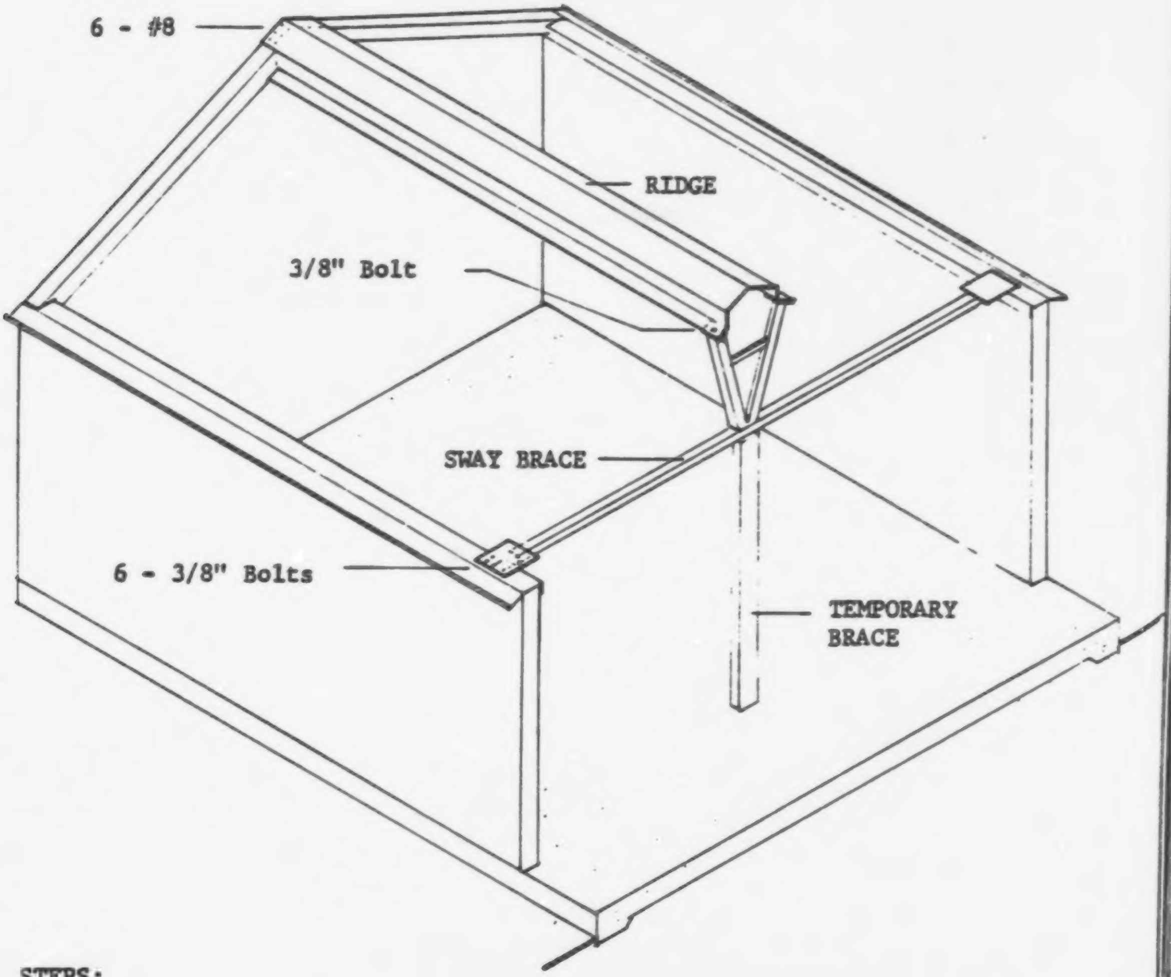
1) Install the first CORNER PANEL starting on the left end of one side wall. Make sure panel is plumb.
2) Install adjacent WALL PANELS, working left to right, and continue around building until all walls are erected.
3) Install TOP CHANNEL and DRIP as soon as enough wall panels are erected to accomadate each length of top Channel.
4) Straighten walls and apply temporary bracing to keep walls straight until roof is installed.

NOTES:

a) Notch each panel rib at the bottom so that the exterior face of the wall panel will slip over the front of the bottom channel.
b) Fasten panels thru ribs only (one near bottom, one near top and one centered) until a section of wall is complete, then complete fastening of panels to bottom and top channels after walls are aligned.
c) Stagger joints of top channel and drip.

* * *

STEP 3. INSTALLATION OF SWAY BRACES, "A" FRAMES AND RIDGE.



STEPS:

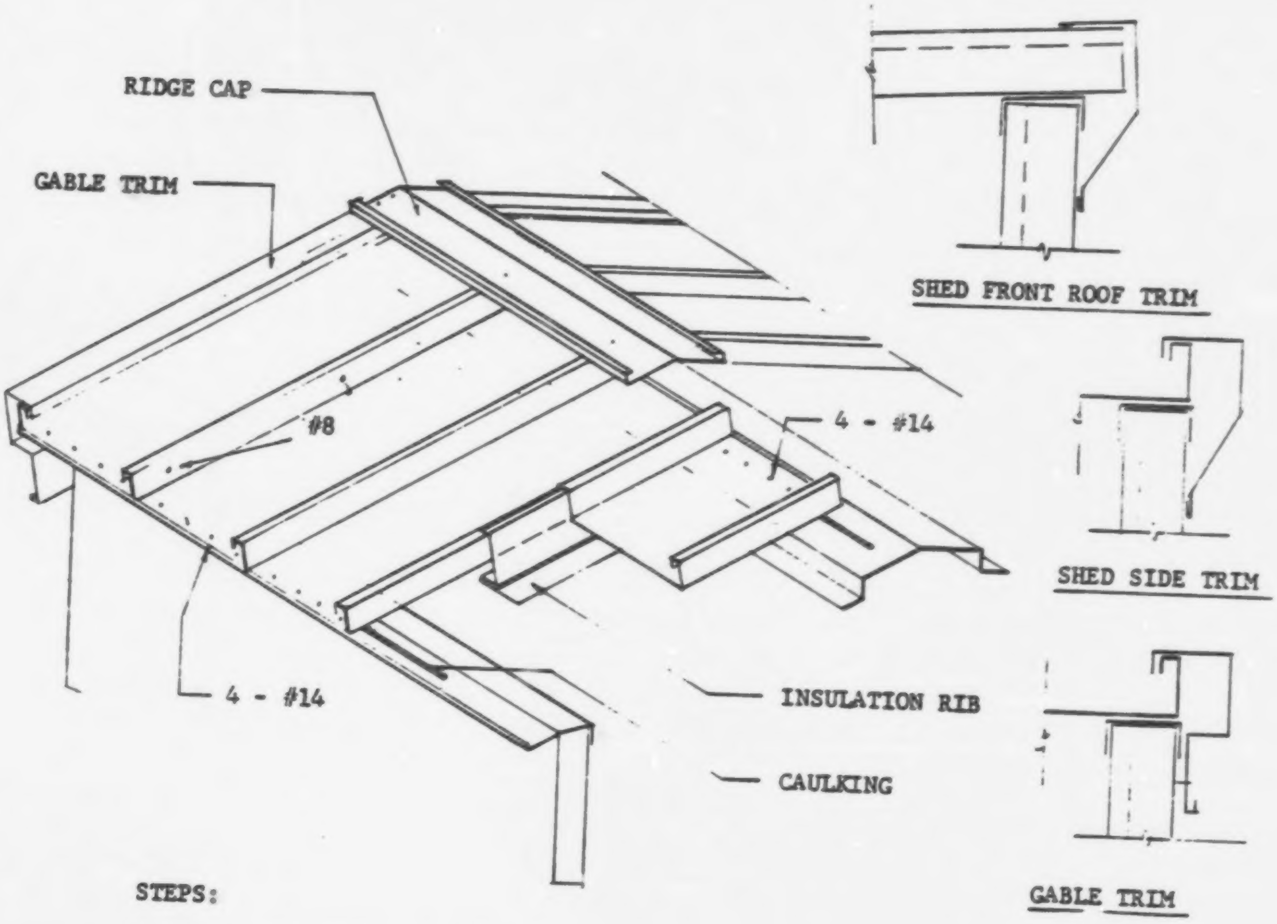
1) Install SWAY BRACES with spacing as shown on building shop drawings.
2) Bolt "A" FRAMES to center of SWAY BRACES.
3) Support center of sway brace with a temporary brace (ie. 2x4). Leave brace in place until roof is installed.
4) Install RIDGE as shown, splicing as required (min. 6" lap) with #8 self tapping screws.

NOTES:

a) Sway braces should have a ½" crown per 10' of building width prior to installation of roof panels.
b) Splices in ridge should not be more than 1' from "A" frames.
c) Smaller buildings do not require "A" frames.

* * *

STEP 4. INSTALLATION OF ROOF PANELS AND ROOF TRIM



SHED FRONT ROOF TRIM

SHED SIDE TRIM

GABLE TRIM

STEPS:

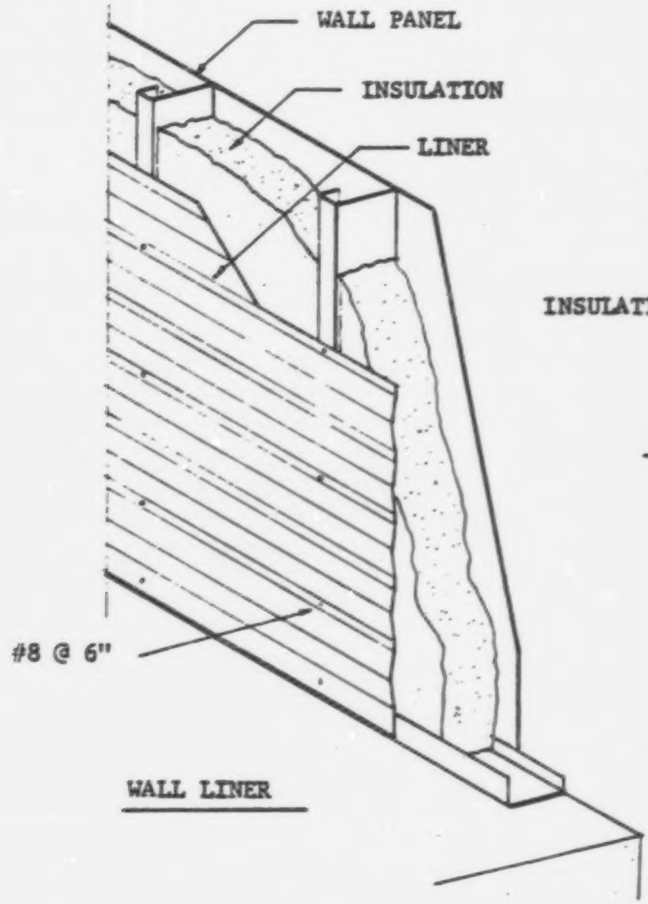
1) Place a bead of caulking along the length of both eave drips and ridge.
2) Begin installation of ROOF PANELS from one end, starting with a '2SE' (two small end) roof panel.
3) Complete installation of the remaining roof panels with the small rib on the leading edge.
4) Install ROOF TRIMS. On Shed Roofs, install side trims first, and then the shed front trim, mitering to fit side trims. On gable roofs, install gable trims first and then the nameplates.
5) Install RIDGE CAP as shown on drawings.

NOTES:

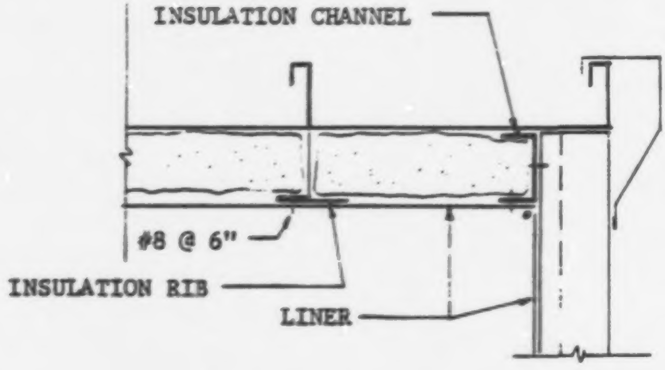
a) On Gable roofs, panels on both sides of the roof must be erected at the same time to balance loading on the ridge.
b) Insulation Ribs must be installed as the roof panels are being installed. (Insulated buildings only)

* * *

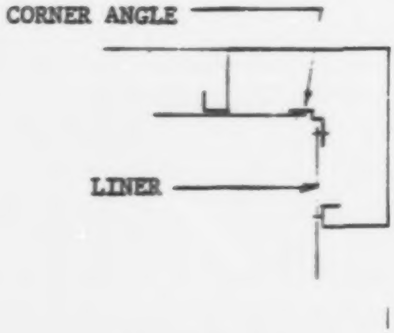
STEP 5. INSTALLATION OF INSULATION AND LINER


WALL PANEL
INSULATION
LINER
#8 @ 6"

WALL LINER


INSULATION CHANNEL
#8 @ 6"
INSULATION RIB
LINER

ROOF LINER AND INSULATION CHANNEL


CORNER ANGLE
LINER

CORNER ANGLE

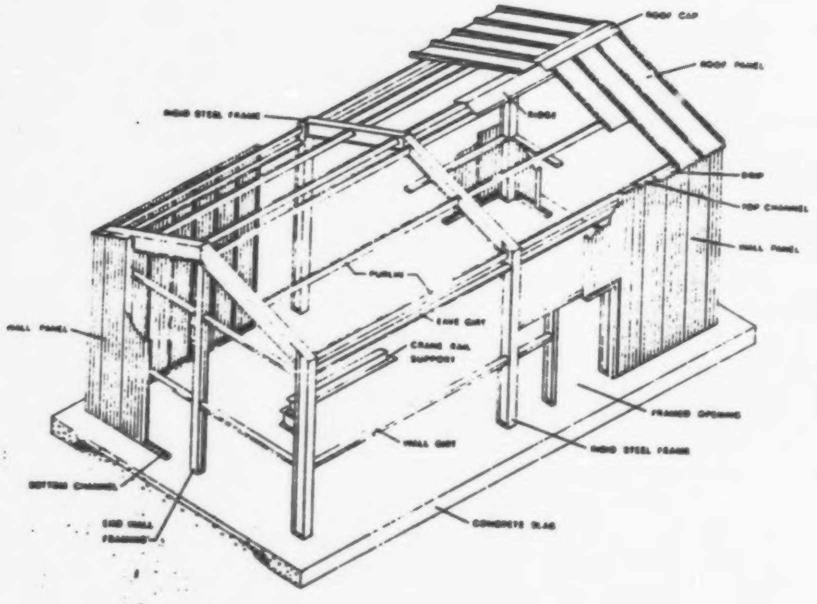
STEPS:

1) Install INSULATION CHANNELS and CORNER ANGLES.
2) Install Friction Fit insulation between all wall panel ribs and roof INSULATION RIBS. (see roof installation instructions)
3) Install VAPOUR BARRIER if specified.
4) Install LINER, starting at the bottom of walls.

NOTES:

a) Lap horizontal joints on liner the width of one complete flute.
b) Lap vertical joints in liner with 3" lap so that joint falls between wall panel ribs. (not over rib)
c) Line up vertical joints in liner for best appearance.
d) Screw liner on roof thru the double layer portion of the insulation rib.

* * *

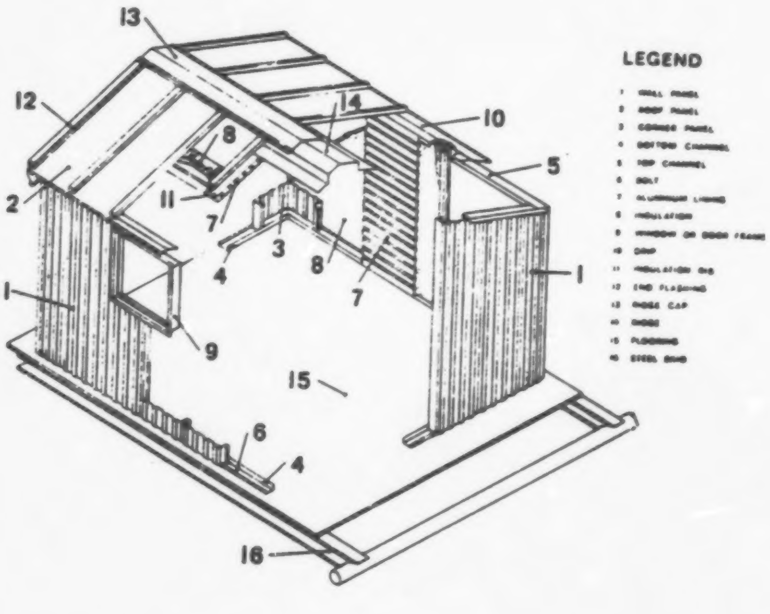

ROOF CAP
ROOF PANEL
RIGID STEEL FRAME
RIDGE
DRIP
TOP CHANNEL
WALL PANEL
PURLIN
EAVE GIRT
WALL PANEL
CRANE RAIL SUPPORT
FRAMED OPENING
RIGID STEEL FRAME
WALL GIRT
BOTTOM CHANNEL
END WALL FRAMING
CONCRETE SLAB

Rigid Frame Steel Type Building

RIGID FRAME BUILDINGS are in every case, designed to specific requirements. All dimensions, cranes and accessories are specified by our customers or their consultants. These buildings are extremely versatile and are used in such instances where dimensions and loadings preclude the use of a Self Framing Building.

Self-Framing Steel Building

SELF FRAMING BUILDINGS are the most economical metal buildings in use today. Wall and roof panels are of pre-engineered design and vary only in the gauge (thickness) of metal and in some instances width of the panels to achieve desired strength. Self Framing Buildings, which meet all codes are supplied in any dimensions not exceeding 32′ width x any length x 16′ eave height.


13
12
14
10
8
5
2
11
7
3
4
8
7
1
1
9
15
6
4
16
LEGEND
1 WALL PANEL
2 ROOF PANEL
3 CORNER PANEL
4 BOTTOM CHANNEL
5 TOP CHANNEL
6 BOLT
7 ALUMINUM LINING
8 INSULATION
9 WINDOW OR DOOR FRAME
10 DRIP
11 INSULATION
12 END FLASHING
13 RIDGE CAP
14 RIDGE
15 FLOORING
16 STEEL SKID

ALL RONACO METAL BUILDINGS are individually designed to meet the standards set forth in the latest "Metal Building Manufacturers Association" manuals, the manuals and supplements issued by the "Associate Committee on the National Building Code, National Research Council of Canada," as well as any local codes which may be in force in any specific area. All materials used in the manufacture of our buildings are of a quality which agrees with the foregoing. The only exceptions to this policy are in such cases where customer's specifications call for higher standards than code requirements. Galvanized steel siding and roof decking is normal. Aluminum siding and roof decking or steel with a baked on coloured enamel finish are used in corrosive atmospheres or for esthetic reasons. Noise attenuating materials in place of standard insulation and lining are available and are designed to meet specific requirements.

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INDUSTRIES LTD.

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Calgary, Alberta
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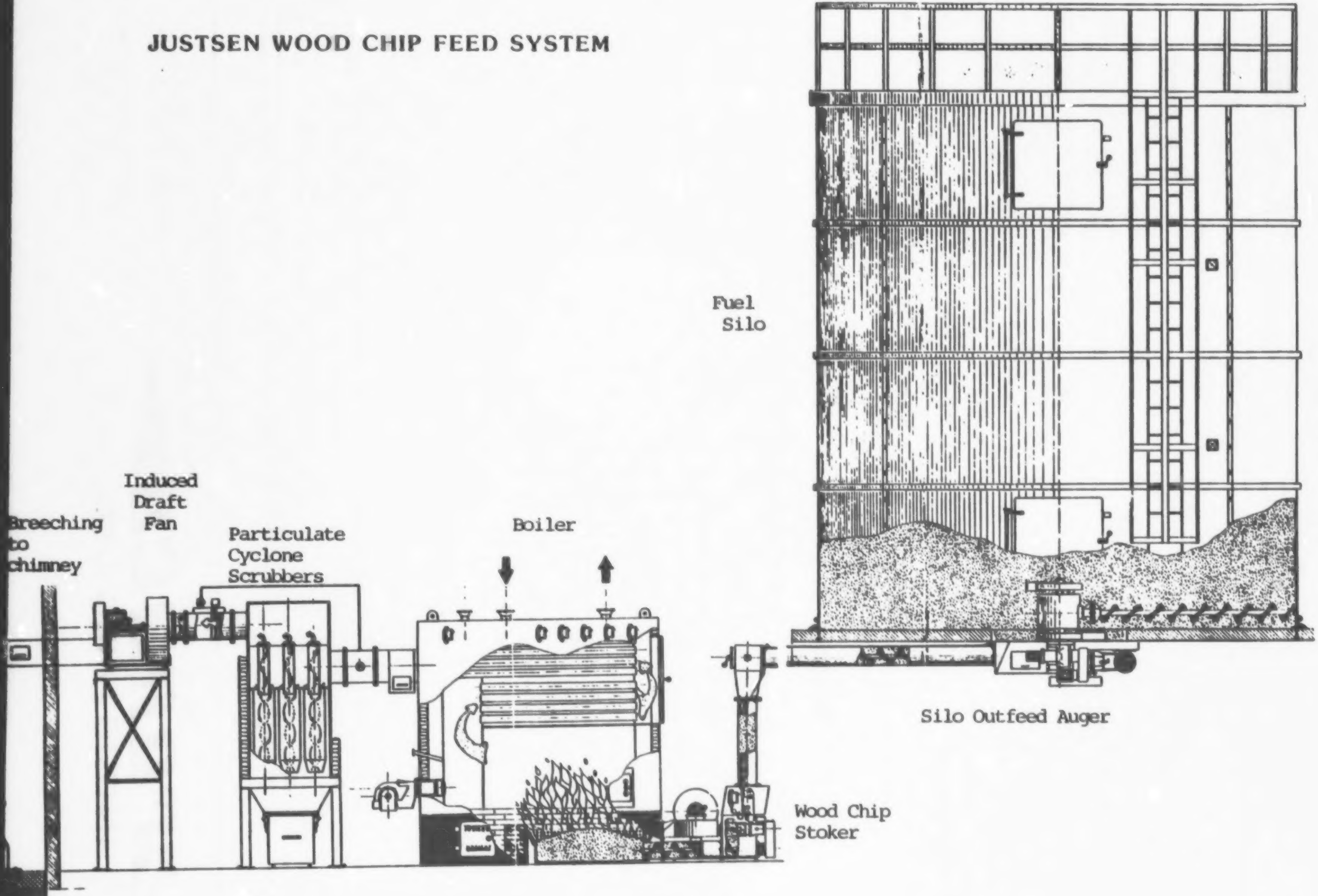
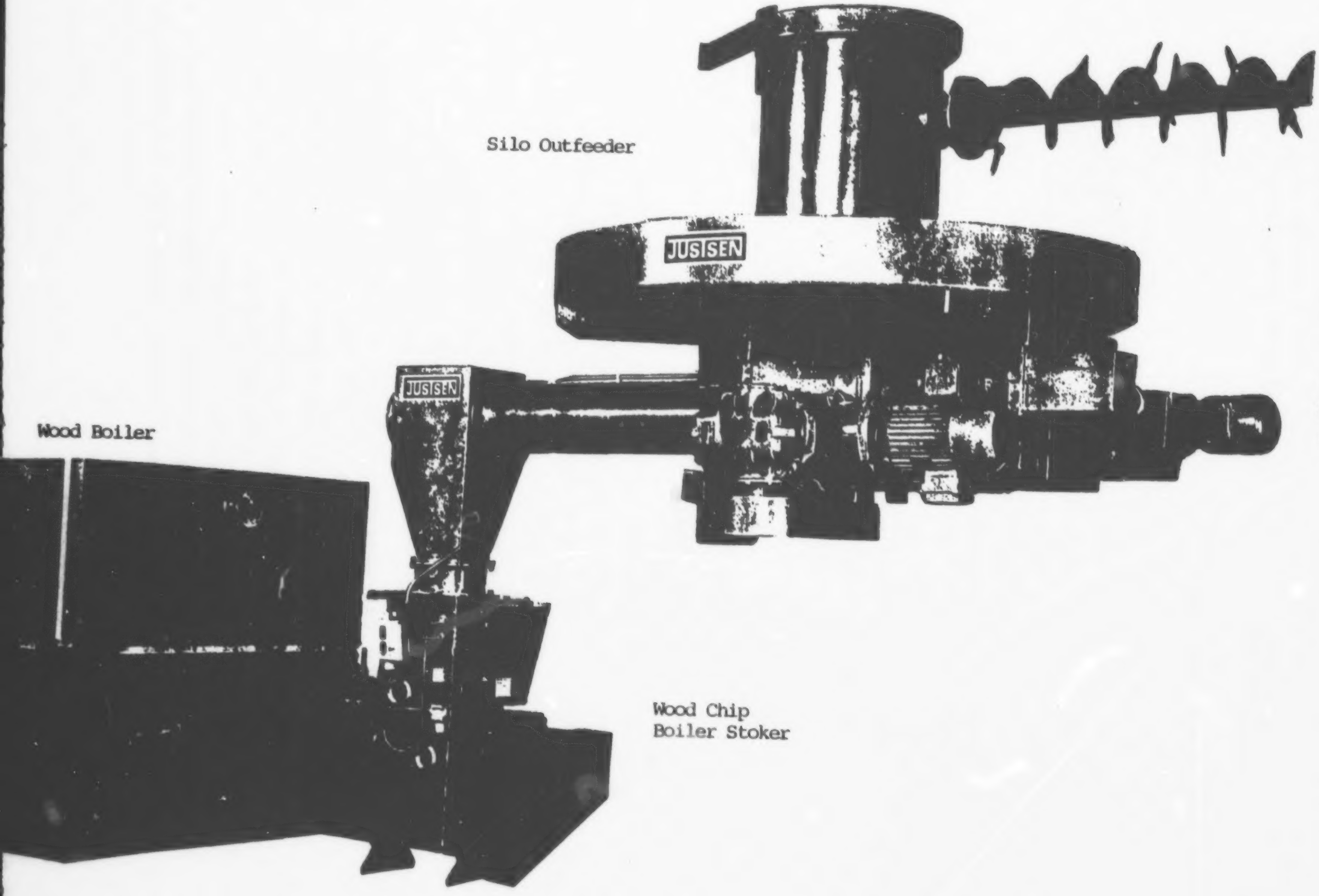
JUSTSEN WOOD CHIP FEED SYSTEM


Breeching
to
chimney
Induced
Draft
Fan
Particulate
Cyclone
Scrubbers
Boiler
Fuel
Silo
Silo Outfeed Auger
Wood Chip
Stoker


Silo Outfeeder
JUSTSEN
JUSTSEN
Wood Boiler
Wood Chip
Boiler Stoker

5.0 BOILER SYSTEM COSTS AND ECONOMIC VIABILITY

5.1 GENERAL

The capital costs, incremental operating costs, and resulting economic viability for the installation of stand alone wood fired boiler systems are assembled in this section. Each of the buildings addressed by this study is examined in separate subsections to follow.

Capital costs are based upon vendor price lists, or job quotations for equipment or materials services to be rendered in mid- to late 1984, unless otherwise noted. No attempt was made to negotiate volume discounts or package price discounts on the possible supply of more than one unit.

Economic viability is calculated, in each case, by comparing the net present value of the incremental operating cost savings, due to the adoption of a wood fired heating system, to the capital costs required to install such a system. To avoid unsubstantiatable complications, the value of operating cost savings is assumed to remain constant in real terms from year to year. The required rate of return on these wood conversion "investments" (i.e. the discount factor, r) is set to be 7%. A twenty year (r = 20) project lifetime is assumed for baseline calculations.

$$\text{Net Present Value} = \sum_{i=1}^{n} \text{of} \left(\frac{\text{SVGS}}{(1 + r)^{i}}\right) - \text{capital costs}$$

If the net present value is positive, i.e. the discounted summation of savings, exceeds the original capital cost, the project is considered viable. The ratio of net present value of savings to capital is also computed as a measure of "effectiveness" of the proposed project.

A viability calculation referred to as simple payback analysis is also performed as another viability measure for consideration.

Throughout the capital cost analysis, no explicit costs were included for land to place a boiler building, since the land is already owned by the building owner. No costs are included for the costs by a building owner for the planning, applications for financing and grants, decision analysis, or other preliminary administrative activities an owner may undertake prior to approving a project to proceed.

WOOD FUEL COSTS

The cost of chipped and delivered wood fuel to the boiler plant location is a primary parameter in the economic analysis. Earlier wood boiler feasibility assessments have examined the cost of wood fuel, both from a viable business venture perspective and from "as-found" market conditions. Reference 2 suggested a stable business venture in Fort Smith should charge $79.86 (1982 dollars) for chipped and delivered wood fuel in order to cover business expenses and provide a return on investment. Reference 3 employed a figure of $91.00 per chipped cord in Fort Smith (1983-84 heating season) for a wood boiler feasibility analysis connected with the Town of Fort Smith water treatment plant. A Rae-Edzo study, reference 4, indicated a substantial fuel harvesting operation in that community should charge $78.98 per unchipped delivered cord, and $90.43 for a chipped delivered cord (1984 dollars) based on a 2000 cord/year scale of operations.

The Town of Fort Smith, in support of the wood boiler at the water treatment plant, contract for green or firekilled, unchipped pole length fuel wood to be delivered and stacked at the plant site. Generally, a number of small contracts are let to cottage industry wood cutters to meet the requirement. Competition for the contracts is brisk. 1983 prices agreed upon were in the $50-$55 per cord range (unchipped poles delivered and stacked). The 1984 lowest bid price was $35-$40 per cord. (Recall, a price of $91.00 per cord, chipped and delivered was estimated reasonable when all costs of business were considered).

Accordingly, for economic evaluations in this report, two wood fuel cost figures are utilized. A price of $67.00 per chipped and delivered cord ($55 + $12 per cord for chipping) is used as the primary figure, based on the probable cottage industry price for chipped fuel. A price of $91.00 per cord is used for sensitivity analysis purposes.

WOOD HEATING VALUE

The substitution of wood fuel for fuel oil used in this report assumes that air dried (16.67% moisture content, wet basis, or 20% dry basis) jack pine is burned, releasing 21.6 million BTU per cord. Therefore one cord of wood is substituted for (21.2 x10^6/35,030 BTU per litre of fuel oil) 616.6 litres of fuel oil.

5.2 NEW FEDERAL BUILDING

The wood boiler system proposed for addition to the new federal building is a single 30 boiler horsepower (1.0 million BTU/hr., 293kw) hot water boiler, located in a separate building 10 m directly north of the present boiler room. The boiler is assumed to be a Bell Industries Compak Series fire box boiler, fitted with a North Fab Systems fuel stoker and a 10.0 m^3fuel storage silo. The complete unit is erected within a separate steel clad building on a concrete base. Insulated hot water supply and cold water return lines are run underground from the wood boiler building through to the building foundation wall and into the fuel oil boiler room.

Two boiler tie-in methods are possible, the wood boiler can be placed in series and up stream of the oil boiler, or the wood boiler can be plumbed in parallel with (to bypass) the oil fired equipment. Both methods result in similar plumbing ti-in costs. The series arrangement permits a "warm standby" and is the arrangement illustrated in figure 5.2/1. The separate wood boiler supply temperature control can be mounted remotely on the system supply header, or can be mounted near/on the wood boiler hot water outlet in the wood boiler building.

It is assumed that the originally specified two oil fired boilers are installed in the building and that the boilers are retained for back-up service.

CAPITAL COSTS

The estimated capital costs to install the wood fired boiler unit to serve the federal building are assembled in Table 5.2/1. The estimates assume a standard boiler package is purchased without generic design work done by owner appointed engineering consultants. A technically capable, professional project manager is

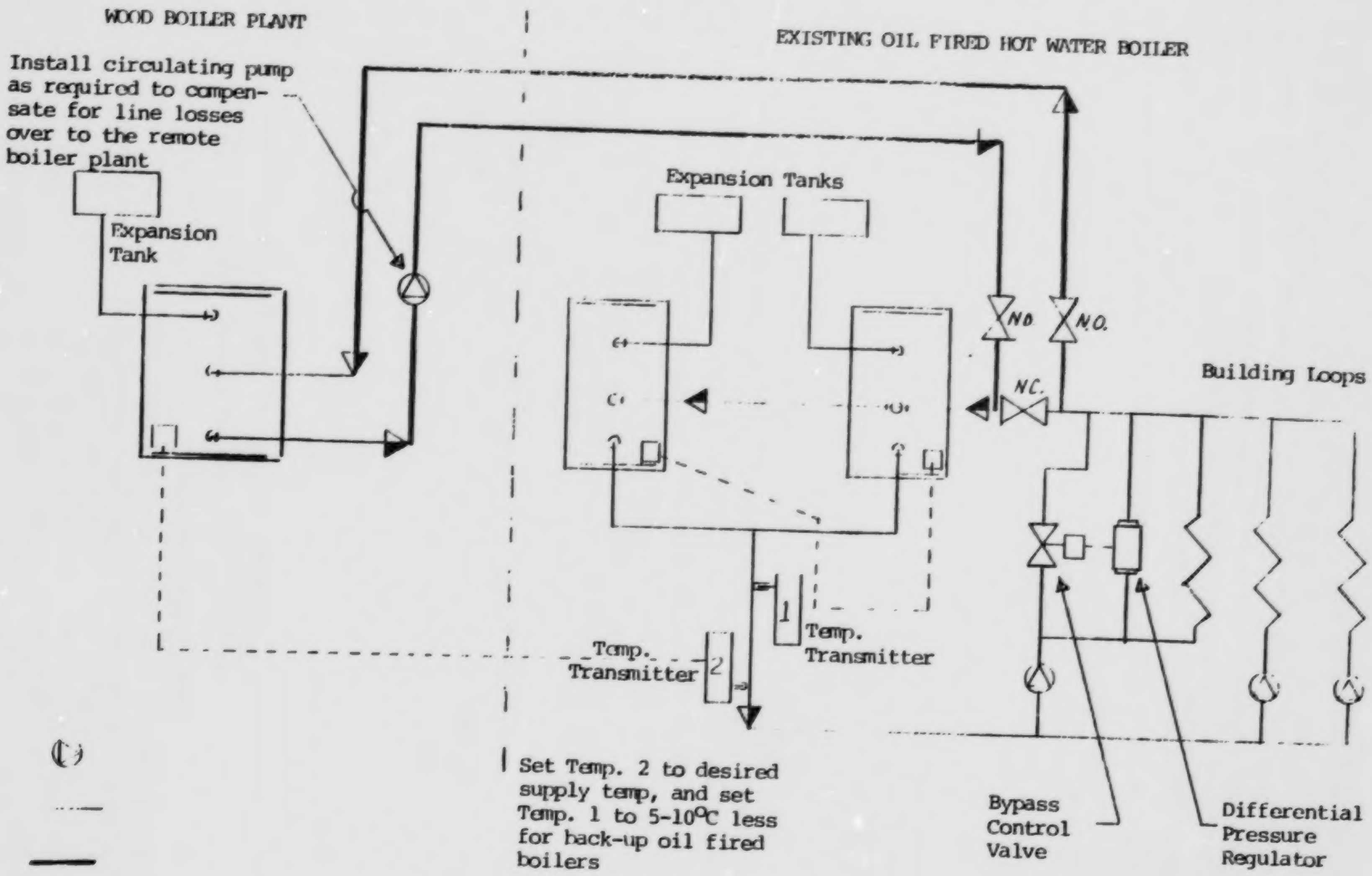

WOOD BOILER PLANT
EXISTING OIL FIRED HOT WATER BOILER
Install circulating pump as required to compensate for line losses over to the remote boiler plant
Expansion Tank
Expansion Tanks
NO
N.O.
N.C.
Building Loops
1
Temp. Transmitter
2
Temp. Transmitter
Set Temp. 2 to desired supply temp, and set Temp. 1 to 5-10°C less for back-up oil fired boilers
Bypass Control Valve
Differential Pressure Regulator

FIGURE 5.2/1 SKETCH OF MODIFIED FLOW CIRCUIT TO INCORPORATE WOOD BOILER assumed to organize the project, and conduct the purchasing of an external pre-engineered boiler plant and building system. Site related construction and tie-in is performed under the supervision of a qualified local contractor, and the work is performed by local certified tradesmen without the benefit of extensive installation drawings and work specifications.

The start-up, commissioning, and training budget item includes only the cost for a factory engineer from the boiler vendor, to lend the start-up and commissioning effort, and to conduct a three day operations and maintenance training session with the owner's designated operator.

INCREMENTAL OPERATING AND MAINTENANCE COSTS

The change in operating and maintenance costs between the use of the planned oil fired equipment, and the wood boiler equipment represent the potential cost savings that may make the wood boiler facility economically attractive. In this case, operating and maintenance costs include fuel costs, electricity costs and labour costs.

The estimated changes in operating and maintenance costs are assembled in Table 5.2/2.

It is assumed that the boiler building and system is supervised by a trained and knowledgeable staff in an efficient manner. Accordingly, arrangements will be made for the delivery of dry wood fuel chips on an as required contract basis. (Wet fuel has a low heating value, and results in higher fuel costs). It is assumed that the wood boiler plant will be inspected on a daily basis, just as an oil fired plant is supervised.

TABLE 5.2/1 CAPITAL COSTS
FEDERAL BUILDING WOOD BOILER INSTALLATION

#	Item	Cost
1.	Bell Compak Series 30 b.h.p. woodfired hot water boiler package c/w Northfab Systems Ltd. feed system including a primary feed stoker, 100 m^3 fuel storage bin, bin outfeed auger.	35,500
2.	Boiler Chimney 24' of 10" diameter insulated steel chimney	2,100
3.	Flue gas particulate cyclone scrubber system	4,400
4.	Boiler Building	
	a) 20' x 30' steel bldg.pkg. - 12' side wall, 4:12 gable roof - erection on site included	14,250
	b) concrete foundation and floor	5,400
	c) municipal services; sewer, water, and power tie-in	3,900
	d) building finishing sub-trades labour and materials; - mechanical - electrical	3,000
5.	Boiler Equipment Erection/ Installation	4,700
6.	Hot Water Supply Line (install & tie-in)	8,500
7.	Start-Up/Commissioning/ Operations Training	5,800
8.	Owner Project Management	10,500
	PROJECT TOTAL CAPITAL COST	$ 98,050

Note: All costs are F.O.B. Fort Smith.

TABLE 5.2/2 ESTIMATED INCREMENTAL OPERATING AND MAINTENANCE COSTS FOR FEDERAL BUILDING WOOD BOILER INSTALLATION

#	Item	Annual Cost
1.	Fuel Costs (Savings)	
	- Fuel Oil $ saved	
	52630 l/yr x $0.40/l	($21,052)
	- Wood Fuel Used	
	$52630 \text{ l} \times \frac{\text{1 cord}}{\text{616.6 l}}$ = 85.3 cords	
	x $67.00/cord	$ 5,719
2.	Labour Costs	
	- normal operator supervision	nil
	- annual servicing and wood boiler inspection	$ 1,500
3.	Electricity	
	$0.18 per kwh	$ 95
	TOTAL INCREMENTAL OPERATING & MAINTENANCE COSTS (SAVINGS)	($13,738)

NOTE: Wood fuel is assumed to have an as-fired heating value of 21.6×10^6 BTU/cord. The substitution calculation shown implies that the oil boiler and wood boiler operate at the same efficiencies.

Incremental maintenance due to the wood boiler is assumed to include the labour cost of a mid-season cleaning, and an end of season cleaning and safety inspection (GNWT Safety Division Boiler Inspector). The draft fan in a wood boiler unit is larger than a fan in the equivalent size oil boiler. (In this case 1150 watt versus 750 watt). The added electricity to operate the larger fan is accounted for.

The net cost saving created by a wood boiler plant, configured as described here, is estimated to be $13,738.00 per year.

VIABILITY ANALYSIS

The economic viability of this wood boiler project is evaluated in terms of the life cycle cost analysis outlined in Section 5.1. Following the algorithm

1. Capital Cost: $ 98,050
2. Annual Net Operating Savings (Costs):
   - o Energy 21052 - 5719 = $ 15,333
   - o Operations & Maintenance (1,595)

   NET $ 13,738
3. Discounted Net Operating Savings:

   n = 20 years
   r = 7% per annum (∴ DF = 10.594) $145,540
4. Discounted Net Present Value: (#3 - #1) $ 47,490
5. Effectiveness Ratio: $\frac{\#4}{\#1} = \frac{\$47,490}{\$98,050} = .48$

According to the assumptions of this algorithm, the positive discounted net present value indicates the project is economically viable. The project should proceed ahead of all other competing investments with a lower effectiveness ratio.

The life cycle cost algorithm used above employed a project life time of 20 years. Since boiler life times are typically 30 years, the ultimate net present value may exceed the result computed here.

It can be shown from the algorithm that the project is viable for all project life times exceeding 10 years (ie. the net present value turns positive after 10 years.)

A second, conceptually simple approach to assess economic viability is the simple economic payback period approach. In this opportunity, the payback period is (capital cost/annual savings, 98050/13738) 7.1 years. This suggests that the original capital investment will be recovered from resulting operating savings accumulated over 7.1 years. The figure attaches no time value to money.

SENSITIVITY ANALYSIS

The viability of the project can be affected by a number of factors, each changing the capital cost annual net savings available from the project. The quantitative impact on project viability due to a number of these factors is demonstrated below. The simple economic payback period viability calculation is used for comparison purposes.

a) Oil Boiler Not Purchased

The "baseline" scenario described in this section assumes that a fully redundant oil fired boiler installation is in place. Since one oil fired boiler is essentially able to carry the whole building load, if the lights are left on and the building is occupied, the heating option has double redundancy if the wood boiler is added. Therefore, if the wood boiler facility is constructed as part of the federal building erection, the incremental capital costs attributed to the wood boiler plant could be significantly reduced from $98,050 if one oil boiler was omitted from the system. The capital costs could perhaps be reduced to $75,000 resulting in a project payback period of (75,000/13738) 5.5 years.

b) Wood Moisture Content

The use of partially wet wood, with a moisture content of 30% w.b. (18.15 x 10^6 BTU/cord) as opposed to air dry wood, results in an increase in seasonal wood requirements from 85.3 cords to 101.5 cords. At $67.00 per cord, the net annual savings are reduced to $12,653.00, and the payback period is extended to 7.7 years.

c) Cost of Wood Fuel

If the cost of air dried wood fuel was $91.00 per cord rather than $67.00, the annual cost savings would be reduced to $11,695.00, extending the payback period to 8.4 years.

5.3 RCMP Detachment Office

The wood boiler system considered for the RCMP detachment office consists of a 10 b.hp. (334,500 BTU/hr.) Bell Dual Pak Series II wood boiler, a Justsen wood chip stoker, and a Justsen 10 m^3 chip fuel silo and auger type outfeeder system. The equipment is housed in a separate new building, to be erected 10 metres north of the existing office. The building proposed is a 15' x 24' x 10' sidewall gable roofed self-framing steel clad structure as outlined in section 4.0. The building and boiler are erected on a concrete pad. An insulated hot water supply line and cold water return line are run underground from the boiler building to the detachment building north wall. The lines enter the building at grade level in the stairwell and follow the stairwell and roof line into the second floor mechanical room. The line pair is split, and plumbed into heat transfer coils fitted into the existing hot air furnaces. Separate thermostats are installed adjacent to existing furnace thermostats and used to control hot water flow through the heat transfer coil in each furnace. If the oil furnace thermostats are set back relative to the hot water thermostats, the oil furnace burners will not normally operate. A temperature control also will be added to the water discharge side of the heat transfer coil to turn on the furnace blowers in response to hot water flow.

A sketch illustrating the furnace conversion is presented in Figure 5.3/1. The hot air furnace equipment remains functional to back up the wood boiler supplied heat.

CAPITAL COSTS

An estimate of the capital costs to install and tie-in a dedicated wood boiler system to the RCMP detachment office heating system is assembled in Table 5.3/1.

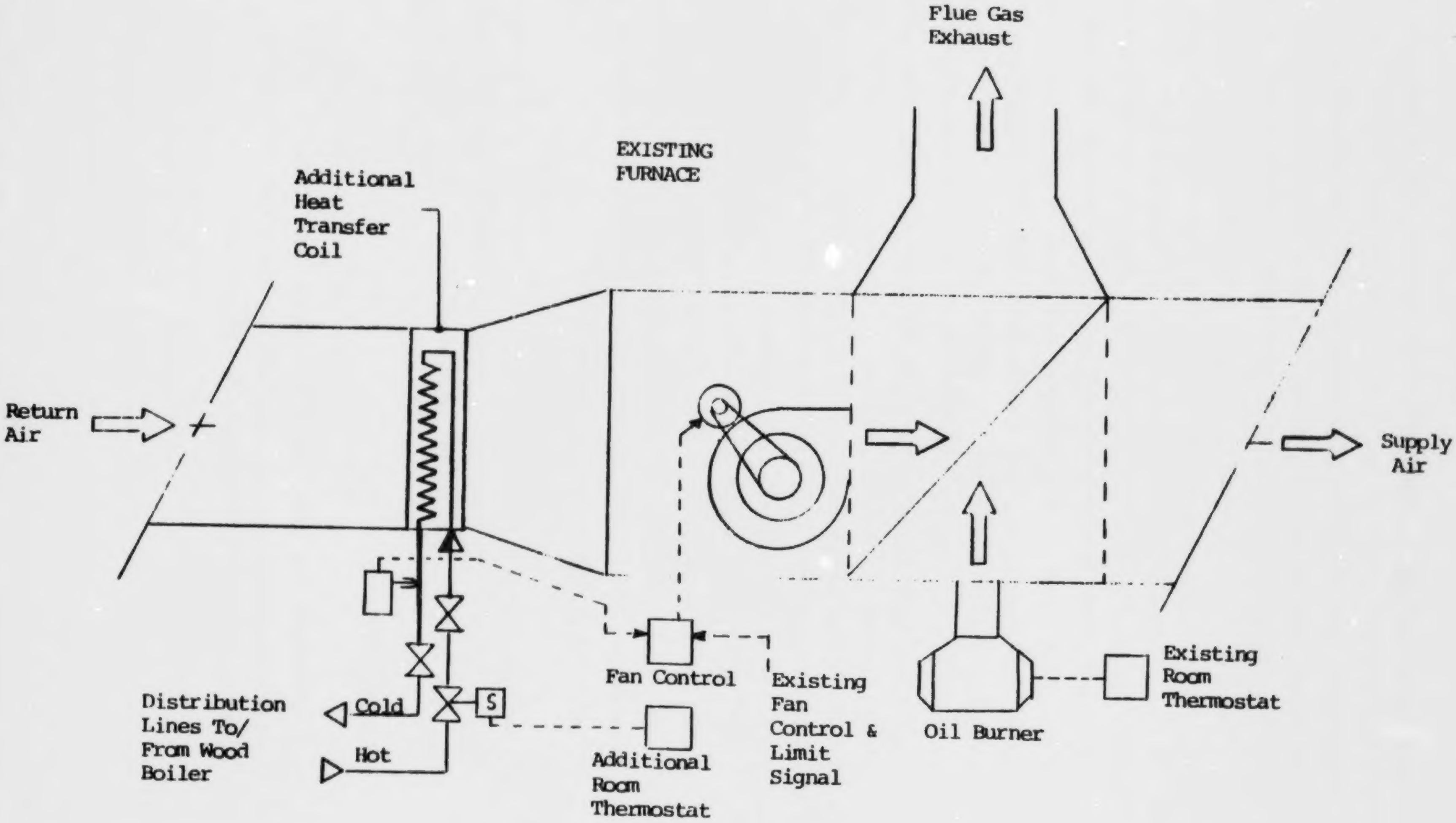

Flue Gas
Exhaust
EXISTING
FURNACE
Additional
Heat
Transfer
Coil
Return
Air
Supply
Air
S
Cold
Hot
Distribution
Lines To/
From Wood
Boiler
Fan Control
Existing
Fan
Control &
Limit
Signal
Additional
Room
Thermostat
Oil Burner
Existing
Room
Thermostat

FIGURE 5.3/1 CONVERSION OF HOT AIR FURNACE SYSTEM TO ACCEPT HEAT FROM AN EXTERNAL HOT WATER SOURCE

TABLE 5.3/1 CAPITAL COSTS
RCMP DETACHMENT WOOD BOILER INSTALLATION

#	Item	Cost
1.	Bell Dual Pak Series 10 b.hp. woodfired hot water boiler package c/w Justsen feed system including a primary feed stoker, 10.0 m^3 fuel storage bin, bin outfeed auger.	$ 33,000
2.	Boiler Chimney 16' of 10" diameter insulated steel chimney	1,400
3.	Boiler Building	
	a) 15' x 24' steel bldg.pkg. - 10' side wall, 4:12 gable roof - erection on site included	10,500
	b) concrete foundation and floor	4,700
	c) municipal services; sewer, water, and power tie-in	3,900
	d) building finishing sub-trades labour and materials; - mechanical - electrical	2,500
4.	Boiler Equipment Erection/ Installation	4,100
5.	Hot Water Supply System	
	- line installation	9,300
	- exchangers and furnace controls, installed	4,300
6.	Start-Up/Commissioning/ Operations Training	5,800
7.	System Tie-in Design Services	4,000
8.	Owner Project Management	10,500
	PROJECT TOTAL CAPITAL COST	$ 94,500

Note: All costs are F.O.B. Fort Smith.

The cost estimates assume a standard boiler package is purchased without generic design work, or tender preparation by an engineering consultant. A small budget for miscellaneous design work, exchanger sizing, tie-in and controls detailing is allowed. The project is assumed to be conducted under the direction of a technically capable professional project manager. Site supervision and construction is assumed to be completed by local certified tradesmen without the need for extensive installation drawings and work specifications.

Incremental Operating and Maintenance Costs

The reduction in Operating and Maintenance costs due to the addition of a wood boiler system provides the basis for its economic attractiveness over fuel oil based systems. The estimated incremental operating and maintenance costs for the proposed wood fuelled boiler installation are assembled in Table 5.3/2.

The following assumptions apply to the tabulated estimates:

a) fuel consumed is assumed to be air dry jack pine or similar species with an as-fired heating value of 21.6 million BTU/cord.

b) combustion efficiencies in a properly maintained wood boiler equal the efficiencies in an oil fired appliance.

c) the wood boiler unit is checked on a daily basis by a tradesman presently employed by the Federal Public Works Department. The cost for this service is absorbed, without charge, into the duties of the tradesman. Routine attendance to the boiler plant of 15 minutes per day is suggested by the manufacturers to be adequate.

d) a wood fuel supply contract is arranged in which fuel is delivered as required by the supplier (as in a fuel oil contract).

Incremental costs to clean the boiler tanks twice per year, and to open up the boiler for annual safety inspection are recognized.

The extra electricity costs for the boiler installation are negligible. The wood boiler selected is a natural draft appliance (has no draft flow) and the hot water circulation pump electricity costs are expected to be nil.

TABLE 5.3/2 ESTIMATED INCREMENTAL OPERATING AND MAINTENANCE COSTS FOR RCMP DETACHMENT WOOD BOILER INSTALLATION

#	Item	Annual Cost
1.	Fuel Costs (Savings)	
	- Fuel Oil $ saved	
	20582 l/yr x $0.40/l	($ 8,233)
	- Wood Fuel Used	
	$20582 \text{ l} \times \frac{1 \text{ cord}}{616.6 \text{ l}} = 33.4$ cords	
	x $67.00/cord	$ 2,238
2.	Labour Costs	
	- normal operator supervision	nil
	- annual servicing and maint.	
	- extra cleaning and wood boiler inspection	$ 1,500
3.	Electricity	
	$0.18 per kwh	nil
	TOTAL INCREMENTAL OPERATING & MAINTENANCE COSTS (SAVINGS)	($ 4,495)

NOTE: Wood fuel is assumed to have an as-fired heating value of 21.6×10^6 BTU/cord. The substitution calculation shown implies that the oil boiler and wood boiler operate at the same efficiencies.

Viability Analysis

The economic viability of the proposed stand alone wood boiler system to serve the RCMP detachment building is assessed using the life cycle cost analysis method described in Section 5.1. Following the procedure, for a 20 year life time:

1. Capital Cost: $ 94,500
2. Annual Net Operating Savings (Costs):
   - o Energy 8233 - 2238 = $ 5,995
   - o Operations & Maintenance (1,500)

   NET $ 4,495
3. Discounted Net Operating Savings:

   n = 20 years
   r = 7% per annum (∴ DF = 10.594) $ 47,620
4. Discounted Net Present Value: $-46,880
   (#3 - #1)
5. Effectiveness Ratio: $\frac{\#4}{\#1}$ = ________ = nil

Conclusion

The life cycle cost savings of this project do not exceed the capital and life cycle costs of the project over a 20 year time span. The project is therefore not viable on this basis, and should not be pursued.

On a simple payback basis (attaching no time value to money), the payback period required to recover initial capital costs from annual cost savings is (94,500/4485) 21 years.

5.4 GNWT REGIONAL HEADQUARTERS BUILDING

The regional headquarters building is heated by means of three hot water boilers located in two rooms in the building basement. The presently installed boiler capacity (887,000 BTU/hr) is reported to handle peak heating loads easily. For the purposes of this analysis, a single 25 b.h.p. (838,000 BTU/hr output capacity) automatic wood fired boiler is considered as a suitably sized unit, with the existing three oil fired boilers remaining in a stand-by service role.

The equipment considered here includes a Bell Compak Series 25 b.h.p. wood boiler, a Northfab automatic boiler stoker, fuel storage bin, fuel bin auger-type outfeeder, and system controls.

It is proposed to locate the wood boiler equipment in a separate new building 20 m. to the west of the headquarters building in space presently utilized for vehicle parking. The building considered is a steel clad structure as outlined in Chapter 4.0. Insulated heating lines are buried from the heating plant foundation wall, and enter the headquarters building main boiler room below grade level. It is proposed to tie into the present return water manifold and connect the lines from the remote wood boiler unit. A second short circulation loop must be added to tie together the manifold in the main boiler room with the Viking boiler located in the 'T' portion of the building. A sketch of the plumbing additions is presented in Figure 5.4/1.

CAPITAL COSTS

The estimated capital costs to install and tie-in the stand-alone wood boiler package are assembled in Table 5.4/1. The cost estimates assume a complete standard boiler package is purchased on a turn-key contract basis without detailed generic design work and contruction tendering. The turnkey contract would include building erection, flow line installation, tie-in and burial, and

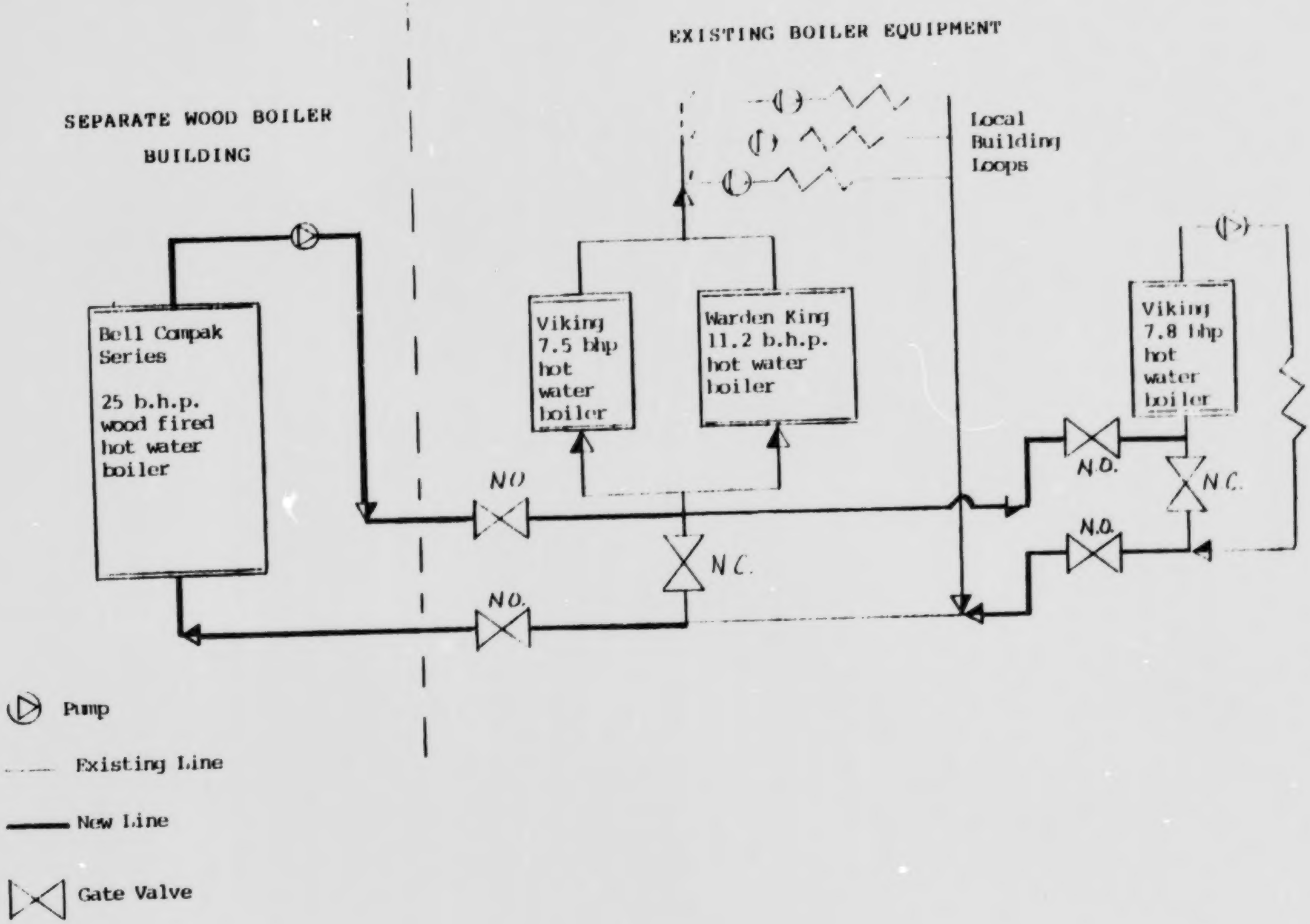

SEPARATE WOOD BOILER BUILDING
EXISTING BOILER EQUIPMENT
Bell Compak Series
25 b.h.p. wood fired hot water boiler
Viking 7.5 bhp hot water boiler
Warden King 11.2 b.h.p. hot water boiler
Viking 7.8 bhp hot water boiler
Local Building Loops
NO
NO.
N.C.
N.O.
N.O.
N.C.
Pump
Existing Line
New Line
Gate Valve

FIGURE 5.4/1 SKETCH OF WOOD BOILER ADDITION TO GNWT REGIONAL H/Q BUILDING

TABLE 5.4/1 CAPITAL COSTS
GNWT REGIONALHEADQUARTERS
WOOD BOILER INSTALLATION

#	ITEM	COST
1.	Bell Compak Series 25 b.h.p. wood fired hot water boiler package c/w Northfab Systems Ltd. feed system including a primary feed stoker, $10.0\ m^3$ fuel storage bin, bin outfeed auger	$ 34,900
2.	Boiler Chimney 24' of 10" diameter insulated steel chimney	2,100
3.	Flue Gas Particulate Cyclone Scrubber System	4,050
4.	Boiler Building	
	a) 20' x 30' steel building package - 12' side wall, 4:12 gable roof - erected on site	14,250
	b) concrete foundation and floor	5,400
	c) municipal services sewer, water, and power tie-in	3,900
	d) building finishing subtrades labour and materials allow. - mechanical - electrical	3,000
5.	Boiler Equipment Erection/Installation	4,700
6.	Hot Water Supply Line	
	a) install and tie-in to main boiler room	13,200
	b) tie together two existing boiler rooms	6,900
7.	Start-Up/Commissioning/Operations Training	5,800
8.	Miscellaneous Design Services allow.	5,000
9.	Owner Project Management	10,500
	Project Total Capital Cost	$113,700

in-boiler room tie ins. A small design allowance is recognized to work out plumbing tie-in details, flow line sizing etc.

INCREMENTAL OPERATING AND MAINTENANCE COSTS

An overall reduction in operating and maintenance costs for the headquarters building heating system is created by the use of the less expensive wood fuel, instead of fuel oil. The estimated incremental O & M savings are assembled in Table 5.4/2. The assumptions listed in Section 5.3 concerning O & M costs also apply here. No incremental cost for wood boiler supervision is assumed.

VIABILITY ANALYSIS

The economic viability of the proposed stand alone wood boiler system to serve the GNWT regional headquarters building is assessed using the life cycle cost analysis method described in Section 5.1. Following the procedure, for a 20 year lifetime:

1. Capital Cost: $113,700
2. Annual Net Operating Savings (Costs):
   - o Energy 24460 - 6644 = $ 17,816
   - o Operations & Maintenance (1,580)

   NET $ 16,236
3. Discounted Net Operating Savings:

   n = 20 years
   r = 7% per annum (∴ DF = 10.594) $172,004
4. Discounted Net Present Value: $ 58,304
   (#3 - #1)
5. Effectiveness Ratio: $\frac{\#4}{\#1} = \frac{\$58,304}{\$113,700} = .513$

TABLE 5.4/2 ESTIMATED INCREMENTAL OPERATING AND MAINTENANCE COSTS FOR GNWT REGIONAL HEADQUARTERS BUILDING WOOD BOILER INSTALLATION

#	Item	Annual Cost
1.	Fuel Costs (Savings)	
	- Fuel Oil \$ saved 61149 l/yr x \$0.40/l	(\$24,460)
	- Wood Fuel Used 61149 l x $\frac{1 \text{ cord}}{616.6 \text{ l}}$ = 99 cords x \$67.00/cord	\$ 6,644
2.	Labour Costs	
	- normal operator supervision	nil
	- annual servicing and wood boiler inspection	\$ 1,500
3.	Electricity \$0.18 per kwh	\$ 80
	TOTAL INCREMENTAL OPERATING & MAINTENANCE COSTS (SAVINGS)	(\$16,236)

CONCLUSION

The life cycle cost savings for this project exceed the capital and life cycle costs of the project by $58,347 over a 20 year time span. The project is therefore viable on this basis, and should be pursued in advance of competing investments with effectiveness ratios lower than .513.

On a simple payback basis (attaching no time value to money), the payback period required to recover initial capital costs from annual cost savings is (113700/16236) 7.0 years.

It can be shown by repeated solution of the life cycle cost analysis, that the project becomes economically attractive for lifetimes in excess of 10 years.

SENSITIVITY ANALYSIS

a) Project Management Costs

The contracting practises of the GNWT may require the engagement of design engineering services to thoroughly design and document the wood boiler package, and to prepare construction tender materials. This exercise could add $30,000 to the capital cost of the project, and would extend the simple economic payback period to 8.9 years.

b) Wood Fuel Costs

Wood fuel costs of $91,00/cord (chipped and delivered) as opposed to $67.00/cord would extend the payback period from 7.0 years to 8.2 years.

c) Wood Boiler Location

The proposed wood boiler could be installed in the basement of the existing building, with the fuel bin and feed auger located outside, adjacent to the building wall. Exterior ground excavation would be required, together with opening the building's concrete foundation, and upgrading the fire spread rating of the selected room. The result may achieve a $7,000 - $10,000 saving in total installed package price, thus improving economic payback from 7.0 years to 6.4 years.

5.5 WINERACK BUILDING

A 25 b.h.p. wood fired hot water boiler system is proposed to substitute for the electrical boilers that currently heat the main floor and basement of the building. The wood boiler equipment would be housed in a separate building 10 metres south of the existing structure. Hot water is delivered into the existing boiler room by insulated flow lines run underground from the boiler building to the closest foundation wall, then through the foundation wall, along the basement roof line and into the present boiler room.

The wood fired hot water supply lines are tied into the existing common electric boiler return water line in a similar fashion to the illustration in figure 5.2/1.

The wood boiler equipment assumed consists of a 25 b.h.p. Bell Compak Series wood fired hot water boiler, a Northfab Systems Ltd. boiler stoker, a 10.0 m^3 chip storage bin and bin outfeed auger, and associated controls. The equipment is placed on a concrete base and enclosed in an insulated steel clad building.

Capital Costs

The estimated capital costs to procure and install a wood boiler system to serve the Winerack Building are assembled in Table 5.5/1. The costs assume a standard wood boiler package is purchased and installed on a turnkey basis by a capable wood boiler contractor/supplier. No allowance is made for any costs incurred by the owner to review, analyze or otherwise work to reach an investment decision on this project.

TABLE 5.5/1 CAPITAL COSTS
WINERACK BUILDING WOOD BOILER INSTALLATION

#	Item	Cost
1.	Bell Compak Series 25 b.h.p. woodfired hot water boiler package c/w Northfab Systems Ltd. feed system including a primary feed stoker, 10.0 m^3 fuel storage bin, bin outfeed auger.	34,900
2.	Boiler Chimney 24' of 10" diameter insulated steel chimney	2,100
3.	Flue gas particulate cyclone scrubber system	4,050
4.	Boiler Building a) 20' x 30' steel bldg.pkg. - 12' side wall, 4:12 gable roof - erection on site included	14,250
	b) concrete foundation and floor	5,400
	c) municipal services; sewer, water, and power tie-in	3,900
	d) building finishing sub-trades labour and materials; - mechanical - electrical	3,000
5.	Boiler Equipment Erection/ Installation	4,700
6.	Hot Water Supply Line (install & tie-in)	13,800
7.	Start-Up/Commissioning/ Operations Training	5,800
8.	Owner Project Management	10,500
	PROJECT TOTAL CAPITAL COST	$102,400

Note: All costs are F.O.B. Fort Smith.

Incremental Operating and Maintenance Costs

The changes in operating and maintenance costs due to the addition of a wood boiler (retaining the electric boilers for back-up service) are tabulated in Table 5.5/2. The major cost saving realized is due to the substitution of inexpensive wood fuel in place of electricity. The equivalent energy requirement for wood fuel was derived by analyzing electricity bills for the existing heating system. The current electrical energy costing system for commercial users in Fort Smith is a summation of a demand charge and a sliding scale consumption charge. The demand charge is the greater of $21.20/mo. or $4.25 per month per kilowatt of billing demand. The monthly energy charges are 15.58cents/kwh for 0-100 kwh/mo; 10.63 cents/kwh/mo for the next 400 kwh; 6.52cents/kwh for the balance. (Example: for a load consisting of 2000 kwh/mo and a 10 kw peak demand, the total energy charge is $42.50 demand + $15.58 + $42.52 + 97.80 = $198.40, or 9.9 cents/kwh blended rate).

The overall efficiency of the electrical boiler is assumed to be 100% since no flue gas thermal losses exist and boiler jacket losses are recaptured to provide as-fired heat in the basement space in any case. The efficiency of the wood boiler is assumed to be 75% (ie. 75% of the as-fired energy available in the wood is transferred to the building heat distribution system). Manufacturers of wood boiler equipment claim efficiencies of 80% or greater for properly maintained equipment.

The daily operation of the wood boiler consists of a brief check on performance and notation of operating conditions. It is assumed that this daily monitoring activity is handled in an identical fashion to the present boiler monitoring function, and no explicit incremental costs are recognized. A budget is identified, however, to cover the twice-per season boiler tube cleaning operation recommended by the vendors, and to allow for annual GNWT Safety Division boiler inspections. An allowance to accommodate the extra electricity costs to operate the wood boiler draft fan is made also.

TABLE 5.5/2 ESTIMATED INCREMENTAL OPERATING AND MAINTENANCE COSTS FOR WINERACK BUILDING WOOD BOILER INSTALLATION

#	Item	Annual Cost
1.	Fuel Costs (Savings)	
	- Electricity saved	
	- Wood Fuel Consumed	
	- 200 mwh net required (683 MBTU)	($15,000)
	- 21.6 million BTU/cord .75 boiler efficiency Therefore, 42 cords required x $67.00/cord	$ 2,814
2.	Labour Costs	
	- normal operator supervision	nil
	- servicing and cleaning	$ 1,500
3.	Electricity	
	- to operate wood boiler flue gas fan and extra hot water circulation pump.	$ 80
	TOTAL INCREMENTAL OPERATING & MAINTENANCE COSTS (SAVINGS)	($10,606

NOTE: Wood fuel is assumed to have an as-fired heating value of 21.6×10^6 BTU/cord.

VIABILITY ANALYSIS

The economic viability of the proposed stand-alone wood boiler system for the Winerack Building is assessed using the life cycle cost algorithm presented in Section 5.1. Following the procedure for a 20 year project life time:

1. Capital Cost: $102,400

2. Annual Net Operating Savings (Costs):

   - o Energy 15000 - 2814 = $ 12,186
   - o Operations & Maintenance (1,580)

   NET $ 10,606

3. Discounted Net Operating Savings:

   n = 20 years
   r = 7% per annum ($\therefore$ DF = 10.594) $112,360

4. Discounted Net Present Value: (#3 - #1) $ 9,960

5. Effectiveness Ratio: $\frac{\#4}{\#1} = \frac{\$\ 9,960}{\$102,400} = .097$

CONCLUSION

The life cycle cost savings of this project exceed the capital and life cycle costs of the project by $9,960 over a 20 year time span. The project is, therefore, viable on this basis, and should be pursued in advance of competing investments with effectiveness ratios lower than .097.

It can be shown by repeated solution of the life cycle cost analysis, that the project becomes economically attractive for life times in excess of 16 years.

On a simple payback basis (attaching no time value to money), the payback period required to recover initial capital costs from annual cost savings is (102,400/10606) 9.6 years.

5.6 PELICAN RAPIDS INN

The wood boiler facility proposed to test economic viability for the concept at the Pelican Rapids Inn is a self-contained boiler plant located in a separate building. Since this motel has oil fired boiler equipment situated in two separate locations in the complex, it is proposed to place a 15' x 30' x 10' sidewall, insulated, self-framing steel clad boiler building on a concrete foundation on the east side of the motel, 10 metres from the motel, opposite the boiler room in the existing motel addition. Insulated hot water supply and return lines are run underground from the boiler building to the motel foundation, through the motel sub-floor crawl space, and into the "addition" boiler room. The lines are extended through the sub-floor crawl space into the basement boiler room at the north end of the motel, and tied into the existing oil fired boiler equipment. The flow line requirements are similar to those for the GNWT Headquarters Building, as illustrated in figure 5.4/1. The existing oil fired boilers are retained for back-up or stand-by service.

The wood boiler plant equipment is assumed to consist of a Bell Compak Series 25 b.h.p. (838,000 BTU/hr.) wood fired hot water boiler, a Northfab automatic boiler stoker, a 10.0 m^3 chip fuel storage silo and outfeed auger, and associated system operating and safety controls.

CAPITAL COSTS

The estimated capital costs to procure and install the wood boiler system outlined here are assembled in Table 5.6/1 . The estimates assume a standard boiler package is purchased and the project is completed on a turnkey basis by a suitable equipment vendor/contractor. An allowance is made for the owner to procure the services of a technically competent professional project manager to act on his behalf to arrange contracts and to oversee the construction activity.

TABLE 5.6/1 CAPITAL COSTS
PELICAN RAPIDS INN WOOD BOILER INSTALLATION

#	Item	Cost
1.	Bell Compak Series 25 b.h.p. woodfired hot water boiler package c/w Northfab Systems Ltd. feed system including a primary feed stoker, 10.0 m^3 fuel storage bin, bin outfeed auger.	34,900
2.	Boiler Chimney 24' of 10" diameter insulated steel chimney	2,100
3.	Flue gas particulate cyclone scrubber system	4,050
4.	Boiler Building	
	a) 15' x 30' steel bldg.pkg. - 12' side wall, 4:12 gable roof - erection on site included	12,000
	b) concrete foundation and floor	5,050
	c) municipal services; sewer, water, and power tie-in	3,900
	d) building finishing sub-trades labour and materials; - mechanical - electrical	2,500
5.	Boiler Equipment Erection/ Installation	4,700
6.	Hot Water Supply Line	
	-install & tie-in to "addition" boiler room	14,300
	-tie together two existing boiler rooms	11,500
7.	Start-Up/Commissioning/ Operations Training	5,800
8.	Miscellaneous design services	allow 5,000
9.	Owner Project Management	10,500
	PROJECT TOTAL CAPITAL COST	$116,300

Note: All costs are F.O.B. Fort Smith.

INCREMENTAL OPERATING AND MAINTENANCE COSTS

The net savings in motel heating costs over time when compared to current oil fired heating costs is estimated as shown in Table 5.6/2. Assumptions pertaining to these estimates include:

a) Wood fuel consumed is air dried jack pine or similar species with an as-fired heating value of 21.6 million BTU/cord.

b) combustion efficiencies in a properly maintained wood boiler equal those found in an oil fired boiler.

c) a wood fuel supply contract is arranged so that deliveries are made, as required, without frequent attention by the boiler supervisor.

d) the wood boiler is checked on a daily basis by the motel manager, in a similar fashion to current responsibilities to check the present boiler performance. Routine checks are expected to consume less than 15 minutes per day of time and are not explicitly noted here. The qualifications to supervise wood boilers, as far as the GNWT Boiler and Pressure Vessels Ordinance is concerned, are identical to those required to supervise equivalent sized and output type oil fired boilers.

Additional costs to clean the wood boilers twice per year, open up the unit for annual safety inspection, and to account for the extra electricity used to run the larger flue gas fan in a wood boiler, are recognized in the table.

TABLE 5.6/2 ESTIMATED INCREMENTAL OPERATING AND MAINTENANCE COSTS FOR PELICAN RAPIDS INN WOOD BOILER INSTALLATION

#	Item	Annual Cost
1.	Fuel Costs (Savings)	
	- Fuel Oil $ saved 46165 l/yr x $0.40/l	($18,466)
	- Wood Fuel Used 46165 l x $\frac{\text{1 cord}}{\text{616.6 l}}$ = 74.8 cords x $67.00/cord	$ 5,016
2.	Labour Costs	
	- normal operator supervision	nil
	- extra cleaning and wood boiler inspection	$ 1,500
3.	Electricity $0.18 per kwh blended demand and energy charge	$ 80
	TOTAL INCREMENTAL OPERATING & MAINTENANCE COSTS (SAVINGS)	($11,870)

VIABILITY ANALYSIS

The economic viability of this proposed project is examined using the life cycle cost analysis method described in Section 5.1. Following the procedure, for a 20 year lifetime:

1. Capital Cost: $116,300
2. Annual Net Operating Savings (Costs):
   - o Energy 18466 - 5016 = $ 13,450
   - o Operations & Maintenance (1,580)

   NET $ 11,870
3. Discounted Net Operating Savings:

   n = 20 years
   r = 7% per annum (∴ DF = 10.594) $125,751
4. Discounted Net Present Value: (#3 - #1) $ 9,451
5. Effectiveness Ratio: $\frac{\#4}{\#1} = \frac{\$\ 9,451}{\$116,300} = .081$

CONCLUSION

The life cycle cost savings of this project exceed the capital and life cycle costs of the project by $9,451 over a 20 year time span. The project is, therefore, viable on this basis, and should be pursued in advance of competing investments with effectiveness ratios lower than .081.

On a simple payback basis, (attaching no time value to money), the payback period required to recover initial capital costs from annual cost savings is (116300/11870) 9.8 years.

It can be shown by repeated solution of the life cycle cost analysis, that the project becomes economically attractive for lifetimes in excess of 17 years.

SENSITIVITY ANALYSIS

a) Wood Boiler Location

It may be possible to install the wood boiler in presently enclosed space adjacent to the boiler room in the motel addition. Significant reconstruction of the room would be necessary to create appropriate fire protection ratings, provide an adequate boiler foundation, etc. The fuel storage bin and outfeeder would be enclosed in a small shelter adjacent to the motel. Hot water supply line lengths would be appreciably shortened and some savings in boiler enclosure costs are expected. A net project cost saving of $10,000 may be possible, thus reducing the economic payback period from 9.8 years to 9.0 years.

5.7 PINECREST HOTEL

The wood boiler system proposed for the Pinecrest Hotel consists of a 40 b.h.p. (1,340,000 BTU/hr.) Bell Compak series hot water boiler, a Northfab Systems solid fuel stoker, a 10.0 m^3 wood chip storage silo, and silo outfeed auger. It is proposed to locate the wood boiler in a basement room of the hotel 5-7 metres west of the current boiler room. This room currently has north exterior wall exposure. The wood boiler would be installed by excavating a hole outside of the hotel, opening up the concrete foundation and inserting the wood boiler through the opening onto a prepared concrete base. The opening is resealed. The chip fuel silo is located outside, adjacent to the wood boiler room. A fuel transfer auger is connected between the silo outfeed auger and the boiler stoker, to deliver fuel to the boiler. The new boiler room walls, ceiling and floor finishes must be upgraded to the suitable fire spread rating. A hot water supply line is run from the wood boiler into the existing boiler room and tied into the present hot water supply leader. A cold water return line is added from the current return manifold to the return water inlet on the wood boiler. The existing boilers are retained for back-up service.

CAPITAL COST

The estimated capital costs to supply and install the proposed wood boiler system are assembled in Table 5.7/1. The cost estimates assume a standard wood boiler package is purchased on a turnkey basis without detailed design work or formal tendering. All installation work would be done by qualified local contractors under the supervision of the boiler systems vendor. A small design allowance is made to specify details of the tie-ins and structural modifications.

TABLE 5.7/1 CAPITAL COSTS
PINECREST HOTEL WOOD BOILER INSTALLATION

#	Item	Cost
1.	Bell Compak Series 40 b.h.p. woodfired hot water boiler package	38,600
	c/w Northfab Systems Ltd. feed system including a primary feed stoker, 10.0 m^3 fuel storage bin, bin outfeed auger.	
2.	Boiler Chimney	2,500
	30' of 10" diameter insulated steel chimney	
3.	Flue gas particulate cyclone scrubber system	5,380
4.	Boiler system placement	
	- excavation & hotel foundation hole	2,100
	- equipment foundations	1,200
	- boiler room upgrading	1,900
	- equipment placement & set-up	7,400
5.	Hot water supply line	
	- install and tie-in	4,800
6.	Start-Up/Commissioning/ Operations Training	5,800
7.	Miscellaneous Design Services	allow 5,000
8.	Owner Project Management	10,500
	PROJECT TOTAL CAPITAL COST	$ 85,180

Note: All costs are F.O.B. Fort Smith.

Incremental Operating and Maintenance Costs

The estimated operating and maintenance cost savings, realized by the switch to the less expensive wood fuel, are assembled in Table 5.7/2. It is assumed that chipped wood fuel delivery is arranged on a seasonal contract basis. Daily supervision of the equipment is assumed, as a baseline case, to be integrated into the duties of the resident hotel manager and this represents no increased cost.

TABLE 5.7/2 ESTIMATED INCREMENTAL OPERATING AND MAINTENANCE COSTS FOR PINECREST HOTEL WOOD BOILER INSTALLATION

#	Item	Annual Cost
1.	Fuel Costs (Savings)	
	- Fuel Oil $ saved 109274 l/yr x $0.40/l	($43,710)
	- Wood Fuel Used 109274 l x $\frac{\text{1 cord}}{\text{616.6 l}}$ = 177 cords x $67.00/cord	$11,874
2.	Labour Costs	
	- normal operator supervision	nil
	- annual servicing and wood boiler inspection	$ 1,500
3.	Electricity $0.18 per kwh	$ 110
	TOTAL INCREMENTAL OPERATING & MAINTENANCE COSTS (SAVINGS)	($30,226)

NOTE: Wood fuel is assumed to have an as-fired heating value of 21.6×10^6 BTU/cord. The substitution calculation shown implies that the oil boiler and wood boiler operate at the same efficiencies.

Viability Analysis

The economic viability of this wood heating project is assessed using the life cycle cost analysis method described in Section 5.1. Following the procedure, for a 20 year life time:

1. Capital Cost: $ 85,180
2. Annual Net Operating Savings (Costs):
   - o Energy 43710 - 11874 = $ 31,836
   - o Operations & Maintenance (1,610)

   NET $ 30,226
3. Discounted Net Operating Savings:

   n = 20 years
   r = 7% per annum (∴ DF = 10,594) $320,214
4. Discounted Net Present Value: (#3 - #1) $235,034
5. Effectiveness Ratio: $\frac{\#4}{\#1} = \frac{\$235,034}{\$85,180} = 2.76$

Conclusion

The life cycle cost savings of this project exceed the capital and life cycle costs of the project by $235,034 over a 20 year time span. The project is, therefore, viable on this basis and should be pursued in advance of competing investments with effectiveness ratios lower than 2.76.

It can be shown by repeated solution of the life cycle cost analysis, that the project becomes economically attractive for lifetimes in excess of approximately 3.3 years.

On a simple payback basis (attaching no time value to money), the payback period required to recover initial capital costs from annual cost savings is (85180/30226) 2.8 years.

Sensitivity Considerations

The economic viability of the project can be affected by changes to the costs tabulated in the estimates. The sensitivity to viability due to selected factors is addressed below.

a) Wood Fuel Costs

If the cost of chipped, delivered wood fuel was $91.00 per cord, the annual cost savings due to the wood boiler installation would be reduced to $25,978 per annum, and the simple economic payback period is extended to 3.3 years.

b) Manpower Costs for Operations

The management of the Pinecrest may choose to increase system operating costs by hiring out the supervision of the boiler plant or routine maintenance activities. If operating costs were increased by $10,000 per year, the simple payback period for this project would be extended from 2.8 years to 4.2 years.

5.8 HUDSON BAY STORE

A 25 b.h.p. Bell Compak Series wood chip feed hot water boiler is proposed as the appropriate sized unit to service the heating load represented by the Hudson Bay food store and dry goods retail store. The boiler is supplied with fuel using a Northfab Systems solid fuel stoker, fed from a 10.0 m^3 chip storage silo and silo outfeed auger. The wood boiler equipment is installed in a separate building to be erected as an addition to the current structure. The addition, made on the SE corner of the building, is 20' x 30' in plan area, with insulated steel clad exterior walls, and a concrete base.

An insulated hot water line is plumbed into the building at the 12' drop ceiling level and is run to the proximity of the retail store furnaces in the ceiling space. The line is split, with the second portion extended to the food store furnaces location. At the food store furnaces location, the hot water line is divided again, and connected to the heat transfer coils to be installed in each of the furnace supply plenums. A similar tie-in is made to heat transfer coils installed in the retail store furnaces.

Cold water is gathered from the discharges of the four heat transfer coils and piped back to the wood boiler plant.

Separate themostats are installed adjacent to the existing thermostats and used to operate zone valves in the wood boiler output hot water line to control hot water flow through the heat exchange coils in each furnace pair. If the oil furnace thermostats are set back relative to the hot water thermostats, the oil furnace burners will normally not operate. This control will also be arranged to turn on the furnace air blowers during periods of hot water flow.

Capital Costs

The estimated capital costs to supply and install the proposed wood boiler system are assembled in Table 5.8/1. The estimate assumes that a boiler system package is supplied and installed on a turnkey basis by a suitable boiler systems manufacturer.

Details of the tie-in plumbing, pipe runs, arrangement of mechanical contractors and job supervision are assumed to be provided by the Construction Department of the Hudson Bay Co. in Winnipeg. Some allowance is made in the estimate to recognize these costs.

TABLE 5.8/1 CAPITAL COSTS
HUDSON BAY STORE WOOD BOILER INSTALLATION

#	Item	Cost
1.	Bell Compak Series 25 b.h.p. woodfired hot water boiler package c/w Northfab Systems Ltd. feed system including a primary feed stoker, 10.0 m^3 fuel storage bin, bin outfeed auger.	34,900
2.	Boiler Chimney 24' of 10" diameter insulated steel chimney	2,100
3.	Flue gas particulate cyclone scrubber system	4,050
4.	Building Extension to accommodate boiler equipment	
	a) 20' x 30' steel bldg.pkg. - 12' side wall, 4:12 gable roof - erection on site included	11,850
	b) concrete foundation and floor	4,700
	c) municipal services; sewer, water, and power tie-in	3,900
	d) building finishing sub-trades labour and materials; - mechanical - electrical	3,000
5.	Boiler Equipment Erection/ Installation	4,700
6.	Hot Water Supply Line	
	- install & tie-in	30,500
	- water flow controls & thermostat installed	1,200
	- install heat transfer coils	5,600
7.	Start-Up/Commissioning/ Operations Training	5,800
8.	Miscellaneous Design Services	allow $5,000
9.	Owner Project Management	12,000
	PROJECT TOTAL CAPITAL COST	$129,300

Note: All costs are F.O.B. Fort Smith.

Incremental Operating and Maintenance Costs

The operating and maintenance cost savings created by the use of wood fuel and a wood boiler heating system are estimated as noted in Table 5.8/2. On the instructions of the local Bay management, the cost of day to day supervision of the boiler equipment and minor maintenance work is estimated based upon contracting out for service.

TABLE 5.8/2 ESTIMATED INCREMENTAL OPERATING AND MAINTENANCE COSTS FOR HUDSON BAY STORE WOOD BOILER INSTALLATION

#	Item	Annual Cost
1.	Fuel Costs (Savings)	
	- Fuel Oil $ saved 49998 l/yr x $0.40/l	($19,999)
	- Wood Fuel Used $49998 \text{ l} \times \frac{1 \text{ cord}}{616.6 \text{ l}} = 81$ cords x $67.00/cord	$ 5,433
2.	Labour Costs	
	- normal operator supervision	$ 7,500
	- annual servicing & maint. (cleaning & boiler insp.)	$ 1,500
3.	Electricity $0.18 per kwh	$ 80
	TOTAL INCREMENTAL OPERATING & MAINTENANCE COSTS (SAVINGS)	($ 5,486)

NOTE: Wood fuel is assumed to have an as-fired heating value of 21.6 x 10^6 BTU/cord. The substitution calculation shown implies that the oil boiler and wood boiler operate at the same efficiencies.

Viability Analysis

The economic viability of the Hudson Bay Store stand alone wood heating project is assessed using the life cycle cost analysis method described in Section 5.1. Following the procedure, for a 20 year lifetime:

1. Capital Cost: $129,300
2. Annual Net Operating Savings (Costs):
   - o Energy 19999 - 5433 = $ 14,566
   - o Operations & Maintenance (9,080)

   NET $ 5,486
3. Discounted Net Operating Savings:

   n = 20 years
   r = 7% per annum (∴ DF = 10.594) $ 58,119
4. Discounted Net Present Value: (#3 - #1) $-71,181
5. Effectiveness Ratio: $\frac{\#4}{\#1}$ = ______ = nil

Conclusion

The life cycle cost savings of this project do not exceed the capital and life cycle costs of the project over a 20 year time span. The project is, therefore, not viable on this basis, and should not be pursued.

On a simple economic payback period basis, the initial investment will be recovered from annual cost savings in 23.6 years. As currently proposed, a wood fired heating system would not likely be an attractive investment for the Hudson's Bay Store.

Sensitivity Considerations

a) Boiler Equipment Location

The location proposed for the boiler equipment adjacent to the SE corner of the main store is the most expensive option since a separate building addition is required and the hot water transmission line lengths are long. The least cost option is to place the boiler inside the present building envelope south wall, in the retail store storage area (near the food store side). If the space could be sacrificed, the project capital costs may be reduced by approximately $25,000 resulting in an improvement in economic payback period to 19.0 years.

b) Operating Costs

If the routine supervision of the wood boiler system is assigned to the duties of existing staff, the incremental operating costs could be reduced by $7,500, resulting in an improvement in economic payback period from the base case of 23.6 years to 10.0 years.

5.9 MINISTRY OF TRANSPORT AIRPORT BUILDINGS

Three MOT buildings were considered for possible wood fuel conversion. The buildings are considered on an individual basis in this section. The cost analysis for heating all buildings from a single centrally heated wood boiler plant is briefly addressed in section 5.9.3.

5.9.1 T52 Maintenance Garage

The wood boiler system considered for the maintenance garage consists of a Bell Compak Series water boiler, a Northfab wood chip fuel bin, auger type bin outfeeder, an auger type boiler fuel stoker, and associated controls. Given the operating experience with the current Progress boilers, a 25 bhp (838,000 BTU/hr.) capacity wood boiler unit is chosen to carry the expected peak building heat load. New experience with the effects of the relevant building thermal upgrading may later suggest a further reduction in required capacity to perhaps 20 bhp (The capital cost difference between a 25 bhp and a 20 bhp unit is small however).

The boiler and feed system are planned for placement on a concrete base in a separate steel clad building to be erected adjacent to the NW corner of the maintenance garage.

A plumbing tie-in arrangement similar to that illustrated in Figure 5.2/1 is assumed. Insulated supply lines running between the two buildings are assumed to be underground lines that enter the building enclosures at grade level. The existing oil fired boilers are retained for back-up service.

CAPITAL COSTS

The capital costs for the proposed facility are assembled in Table 5.9/1. The estimates assume the standard boiler package, offered by suitable suppliers is purchased. No costs are included here for owner activities to review or analyze this wood boiler application further, or to undertake any other activities to arrive at a purchase decision. Furthermore, the contracting or project management practices of the owner may add considerable costs to the project (eg. engineering consultant, generic design, contract tender process, construction reporting, etc.) These costs are not estimated here.

Site related construction and tie-in is assumed to be provided by a qualified local contractor without the need for extensive installation work specifications.

The start-up, commissioning and training budget item includes only the services of a boiler vendor factory technician to lead the activity, and assumes a three day operations training session is conducted with the MOT staff.

TABLE 5.9/1 CAPITAL COSTS
MOT MAINTENANCE GARAGE WOOD BOILER INSTALLATION

#	Item	Cost
1.	Bell Compak Series 25 bhp wood fired hot water boiler package. c/w Northfab System Ltd. primary feed stoker, 10.0 m^3 wood chip storage bin, bin outfeed assembly.	$34,900
2.	Boiler Chimney 24' of 10" diameter insulated steel chimney.	2,100
3.	Flue gas particulate cyclone scrubber unit	4,050
4.	Boiler Building	
	a) 20' x 30' steel building package - 12' side wall, 4:12 gable roof - erected on site	14,250
	b) concrete foundation and floor	5,400
	c) municipal services: water, sewer, and power tie-in	3,900
	d) building finishing subtrades labour and materials: - mechanical/electrical allow	3,000
5.	Boiler Equipment Erection/ Installation	4,700
6.	Hot Water Supply Line - install and tie-in	8,500
7.	Start-up/commissioning/ operations training	5,800
8.	Owner Project Management	10,500
	PROJECT TOTAL CAPITAL COST	$97,100

NOTE: materials costs are F.O.B. Fort Smith, N.W.T.

INCREMENTAL OPERATING AND MAINTENANCE COSTS

The change in operating and maintenance costs between the existing heating system and a wood boiler system represents the potential cost savings that lend to project attractiveness and economic viability. The estimated changes in operating and maintenance costs are assembled in Table 5.9/2.

The following assumptions apply to the table:

a) dry wood fuel is assumed with an as-fired heating value of 21.6 million BTU/cord.

b) the combustion efficiences of a properly maintained wood boiler equals the efficiencies of a similar oil fired boiler.

c) the wood boiler unit is operated on a daily basis under the occasional supervision of current MOT maintenance staff. No extra personnel are required.

d) a wood fuel supply contract is arranged in which fuel stocks on land are maintained by the supplier (as in a fuel oil supply arrangement).

Incremental costs are recognized for the added work to clean (brush out tubes) the wood boiler twice per year and to perform an annual safety inspection.

Incremental costs for electricity consumption are recognized since the draft fan in a wood boiler unit is somewhat larger than in a fuel oil fired boiler.

The net cost saving created by a wood boiler plant is estimated to be $6,700 per year.

TABLE 5.9/2 ESTIMATED INCREMENTAL OPERATING AND MAINTENANCE COSTS FOR THE MOT T52 MAINTENANCE GARAGE WOOD BOILER INSTALLATION

#	Item	Annual Cost
1.	Fuel Costs (Savings)	
	- Fuel Oil Saved 28423 l/year x $.40/l	($11,369)
	- Wood Fuel Used 28423 l x $\frac{1 \text{ cord}}{616.6 \text{ l.}}$ = 46.1 cords	
	x $67.00/cord	$ 3,089
2.	Labour Costs	
	- normal operator supervision	nil
	- annual servicing and maintenance extra cleaning and wood boiler inspection	$ 1,500
3.	Electricity	
	$0.18 per kwh blended demand and energy charge	$ 80
	TOTAL INCREMENTAL Operating & Maintenance Costs (Savings)	($ 6,700)

VIABILITY ANALYSIS

The economic viability of this application is evaluated by the life cycle cost analysis outlined in Section 5.1. Following the procedure:

1.	Capital Cost:		$ 97,100
2.	Annual Net Operating Savings (Costs):		
	o Energy 11309 - 3089 =	$ 8,280	
	o Operations & Maintenance	(1,580)	
	NET		$ 6,700
3.	Discounted Net Operating Savings:		
	n = 20 years		
	r = 7% per annum (∴ DF = 10.594)		$ 70,980
4.	Discounted Net Present Value: (#3 - #1)		$-26,120
5.	Effectiveness Ratio: $\frac{\#4}{\#1}$ = ________ = nil		

CONCLUSION

The negative net present value implies the project is economically not viable on a 20 year life cycle cost basis, and the project should not be pursued.

On a simple economic payback period viability calculation, the project capital investment will be recovered from resulting operating savings accumulated over (97,100/6,700) 14.5 years. This method attaches no time value to money.

SENSITIVITY ANALYSIS

The viability of the project is affected by any factors that influence the predicted capital cost or annual net savings created. The effects of some of these factors are quantified below.

a) Boiler Placement in Existing Space

It is conceivable that the new wood boiler is placed in the existing garage space along the north wall and toward the NW cornerof the building. The fuel bin could be located outside, with augered feed transfer to indoors. This arrangement would save some building related costs and is estimated to reduce the project capital cost to approximately $72,000. The simple economic payback is improved from 14.5 years to 10.7 years.

b) Cost of Fuel

If the cost of wood fuel was $91.00 per cord instead of the $67.00 assumed, the net annual savings would be reduced to $5,594, and the economic payback period would be extended to 17.4 years.

c) Moisture Content of Wood Fuel

If wood chips with a moisture content of 30% (wet basis) are used as fuel as opposed to air dried chips (16.67% w.b) the heating value of the fuel is proportionately lower (18.15 million BTU/cord). The total quantity of wood assumed is increased, creating an extension in economic payback period to 15.9 years.

d) Generic Design and Tendering

The engagement of a consultant to perform detailed generic design work, prepare a specification and tender package, and award the job through tender,may add $30,000 to the capital cost of the project. The economic payback period is thereby extended from 14.5 years to 19.0 years.

5.9.2 T83 Terminal Building

The wood boiler system considered for the terminal is a 15 b.h.p. (503,000 BTU/hr) Compak Series Bell Industries Ltd. hot water boiler, complete with an automated wood chip feed system and storage silo supplied by Northfab Systems Ltd. (Stratford, Ontario). The equipment would be housed in a separate building to be erected 10 m north west of the terminal along the runway perimeter fence. The building is assumed to be a self-framing style steel clad building with a concrete floor.

The existing hot water circulation system for the terminal would be interrupted at the oil fired boiler inlet manifold and rerouted through an insulated underground line to the wood boiler. Heated water would be passed from the wood boiler, back through an insulated line, through (or around) the existing oil fired unit and into the building heating distribution loop.

CAPITAL COSTS

The capital costs for the proposed installation are assembled in Table 5.9/3. Assumptions pertaining to the estimates are as per the T52 Maintenance Garage synthesis (section 5.9.1)

INCREMENTAL OPERATING AND MAINTENANCE COSTS

The incremental operating and maintenance costs for the facility are assembled in Table 5.9/4. Assumptions relating to the costs are as per table 5.9/2.

TABLE 5.9/3 CAPITAL COSTS
MOT TERMINAL BUILDING WOOD BOILER INSTALLATION

#	Item	Cost
1.	Bell Compak Series 15 b.h.p. wood fired hot water boiler package. c/w Northfab Systems Ltd. feed system including a primary fuel stoker, 10.0 m^3 fuel storage bin, bin outfeed augers	$33,200
2.	Boiler Chimney: 16' of 8" diameter insulated steel chimney	$ 1,270
3.	Flue gas particulate cyclone scrubber system	$ 3,400
4.	Boiler Building:	
	a) 15' x 24' steel bldg.pkg. - 10' side wall, 4:12 gable roof - erected on site	$10,500
	b) concrete foundation and floor	$ 4,700
	c) municipal services; sewer, water, and power tie-in	$ 3,900
	d) building finishing subtrades labour and materials: - mechanical/electrical allow	$ 2,500
5.	Boiler Equipment erection/ installation	$ 4,700
6.	Hot Water supply line - install and tie-in	$ 9,300
7.	Start-up/commissioning/operations training	$ 5,800
8.	Owner Project Management	$10,500
	PROJECT TOTAL CAPITAL COST	$89,770

TABLE 5.9/4 ESTIMATED INCREMENTAL OPERATING AND MAINTENANCE COSTS FOR THE MOT T83 TERMINAL BUILDING WOOD BOILER INSTALLATION

#	Item	Annual Cost
1.	Fuel Costs (savings)	
	- Fuel Oil Saved 16000 l/yr x $.40/l	($ 6,400)
	- Wood Fuel Used 16000 l x $\frac{1\ \text{cord}}{616.6\ \text{l}}$ = 25.9 cords	
	x $67.00/cord	$ 1,738
2.	Labour Costs	
	- normal operation supervision	nil
	- annual servicing and maintenance extra cleaning and wood boiler inspection	$ 1,500
3.	Electricity 0.18 per kwh blended demand and energy charge	$ 55
	TOTAL INCREMENTAL OPERATING & MAINTENANCE COSTS (SAVINGS)	($ 3,107)

VIABILITY ANALYSIS

The economic viability of this application is evaluated by the life cycle cost analysis outlined in Section 5.1. Following the procedure:

1. Capital Cost: $ 89,770

2. Annual Net Operating Savings (Costs):

   - Energy 6400 - 1738 = $ 4,662
   - Operations & Maintenance (1,555)

   NET $ 3,107

3. Discounted Net Operating Savings:

   n = 20 years
   r = 7% per annum (∴ DF = 10.594) $ 32,916

4. Discounted Net Present Value: (#3 - #1) $-56,854

5. Effectiveness Ratio: $\frac{\#4}{\#1}$ = _______ = nil

Conclusion

The negative net present value implies that the project should not proceed.

The simple economic payback period for this project is (89,770/3,107) 28.9 years.

From the computations this project is not viable as configured. The system substitutes for a modest amount of fuel oil but carries a significant percentage of the capital costs for a wood boiler system of twice or three times the output capacity. In the 10-50 boiler horsepower size ranges the boiler physical space requirements only vary by a factor of perhaps 1.5; chip fuel system requirements are essentially constant; and increased boiler capacity can be purchased for a disproportionately low additional cost.

The terminal building installation is further burdened by the need to build a separate building enclosure to house the wood boiler equipment.

5.9.3 T35 Flight Service Centre and T83 Terminal Building

Given the results of the viability analysis for the terminal building wood boiler system in Section 5.9.2, it can be concluded virtually without analysis that a stand-alone separately housed 6 boiler h.p. wood boiler system to serve the Flight Service Centre would not be economically attractive. A configuration worth some consideration is the extension of the terminal building wood boiler to also serve the Flight Service Centre. This concept is addressed in this sub-section.

The combined heating loads of the two buildings can be met with a single 20 b.h.p. (670,000 BTU/hr.) automated wood chip fuelled boiler system. The Bell Compak Series boiler, together with Northfab Systems Ltd. feed system (stoker, fuel silo, and silo outfeeder) are assumed.

The boiler plant is assumed to be as described in Section 5.9.2 and located 10 m northwest of the terminal as before. An additional 100 m of underground insulated hot water supply line and return line are buried from the wood boiler plant, across the asphalt parking lot north of the terminal, and into the Flight Service Centre existing boiler room. (see figure 2.9/2). All other aspects of the installation are as per the "terminal only" concept outlined in section 5.9.2.

The estimated capital costs for the combined flight service centre - terminal installation are assembled in Table 5.9/5.

TABLE 5.9/5 CAPITAL COSTS - MOT TERMINAL AND FLIGHT SERVICE STATION WOOD BOILER INSTALLATION

#	Item	Cost
1.	Bell Compak Series 20 b.h.p. wood fired hot water boiler package c/w Northfab Systems Ltd. feed system including a primary feed stoker, 10.0 m^3 fuel storage bin, bin outfeed auger.	34,500
2.	Boiler Chimney 16' of 10" diameter insulated steel chimney	1,400
3.	Flue gas particulate cyclone scrubber system	3,700
4.	Boiler Building	
	a) 20' x 30' steel bldg.pkg. - 12' side wall, 4 x 12 gable roof - erection on site included	14,250
	b) concrete foundation and floor	5,400
	c) municipal services; sewer, water, and power tie-in	3,900
	d) building finishing sub-trades labour and materials; - mechanical - electrical	3,000
5.	Boiler Equipment Erection/ Installation	4,700
6.	Hot Water Supply Line	
	-install & tie-in	9,500
	-install and tie-in Flight Service Centre	42,500
7.	Start-Up/Commissioning/ Operations Training	5,800
8.	Owner Project Management	10,500
	PROJECT TOTAL CAPITAL COST	$139,150

Incremental Operating and Maintenance Costs

The additional Operating and Maintenance costs created by the wood boiler facility, as compared to the present costs, are assembled in Table 5.9/6. Assumptions pertaining to the estimates are as per section 5.9/1. The fuel oil consumption for the terminal building was taken as 16,000 l/yr on average. The expected fuel oil consumption for the recently upgraded Flight Service Centre is taken to be 9000 l/yr.

TABLE 5.9/6 ESTIMATED INCREMENTAL OPERATING AND MAINTENANCE COSTS FOR THE MOT TERMINAL AND FLIGHT SERVICE CENTRE WOOD BOILER INSTALLATION

#	Item	Annual Cost
1.	Fuel Costs (Savings)	
	- Fuel Oil $ saved 25000 l/yr x $0.40/l	($10,000)
	- Wood Fuel Used 25000 l x $\frac{61 \text{ cord}}{616.6 \text{ l}}$ = 40.5 cords x $67.00/cord	($ 2,716)
2.	Labour Costs	
	- normal operator supervision	nil
	- annual servicing and maintenance	
	- extra cleaning and wood boiler inspection	$ 1,500
3.	Electricity	
	demand and energy charge	$ 80
	TOTAL INCREMENTAL OPERATING & MAINTENANCE COSTS (SAVINGS)	($ 5,704)

Viability Anal ysis

The economic viability of this dual building configuration is evaluated on a life cycle cost basis, as previously described.

1. Capital Cost: $139,150

2. Annual Net Operating Savings (Costs):

   - Energy 10000 - 2716 = $ 7,284
   - Operations & Maintenance (1,580)

   NET $ 5,704

3. Discounted Net Operating Savings:

   n = 20 years
   r = 7% per annum (∴ DF = 10.594) $ 60,428

4. Discounted Net Present Value: (#3 - #1) $-78,722
5. Effectiveness Ratio: $\frac{\#4}{\#1}$ = ________ = nil

Conclusion

The negative net present value suggests that on a 20 year life cycle cost basis the combined heating system is not viable.

On a simple investment payback basis of evaluation, the economic payback period for this combined building configuration is (139150/5704) 24.4 years. (This approach recognizes no time value to money.)

SENSITIVITY ANALYSIS

a) Additional Tie-In of the Maintenance Garage

A central heating system, located near the terminal, and serving the terminal building flight service centre, and the maintenance garage, can be quickly dismissed as a better option. The costs to run a heat supply line from the terminal to the maintenance garage are estimated to be 1200' x $120.00/ft. = $144,000. Since this cost, in itself, exceeds the cost of a stand-alone plant adjacent to the garage (section 5.9/1), the "three building" option is economically inferior to the "garage only" and "combined terminal-flight service centre" projects taken separately.

6.0 TOWN CORE CENTRAL WOOD BOILER FACILITY

6.1 CONCEPT DESCRIPTION

A single, centrally located wood fired boiler facility maybe suitable to provide heat energy to various downtown core buildings in Fort Smith. These buildings are:

- planned new federal building
- RCMP detachment office
- GNWT regional headquarters building
- Winerack building
- Pelican Rapids Inn
- Pinecrest Hotel
- Hudson's Bay Store

The conceptual design for a suitable wood boiler facility to heat these buildings is described in this section. Capital and operating costs are assembled, and economic viability is assessed.

It is proposed to place a 7,000,000 BTU/hr. (209 boiler horsepower) low pressure steam, wood fired boiler plant on currently vacant property to the west of the NWT regional headquarters building. The property is currently used for vehicle parking and the property title is held by the Government of the NWT, according to Town of Fort Smith land records. A site plan of the downtown core, illustrating boiler plant placement, and the underground steam distribution system, is presented in Figure 6.1/1.

The boiler plant proposed consists of a single low pressure steam boiler and associated wood chip fuel system manufactured and installed by APSCO Engineering Ltd., of Cremona, Alberta. Brochure materials on the proposed system are enclosed on succeeding pages. The wood chip fuel system consists of a

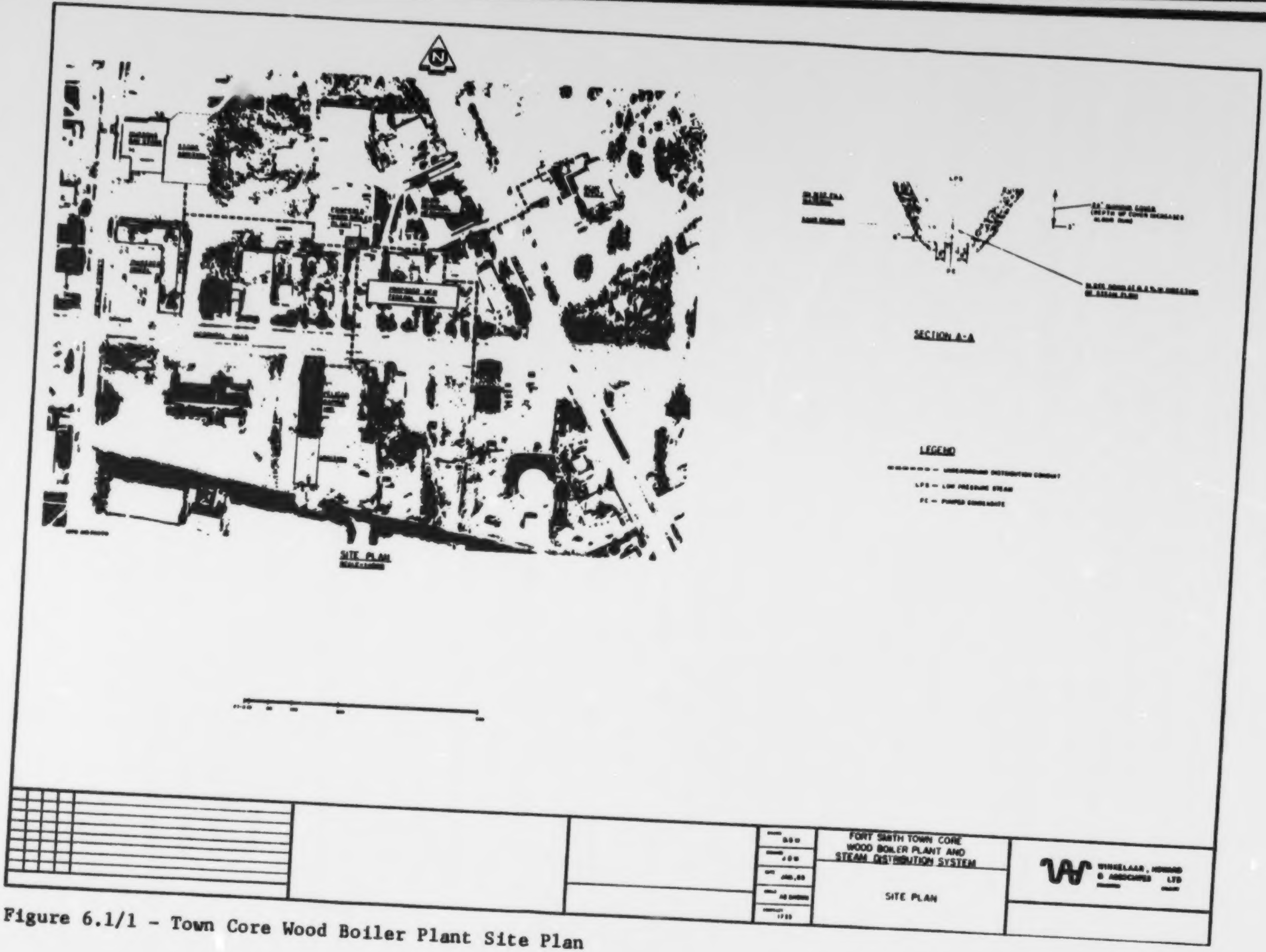

N
SITE PLAN
SECTION A-A
LPS
PC
LEGEND
UNDERGROUND DISTRIBUTION CONDUIT
LPS — LOW PRESSURE STEAM
PC — PUMPED CONDENSATE
FORT SMITH TOWN CORE
WOOD BOILER PLANT AND
STEAM DISTRIBUTION SYSTEM
SITE PLAN
LTD

Figure 6.1/1 - Town Core Wood Boiler Plant Site Plan storage bunker with a hydraulically operated "live bottom" chip movement mechanism, a bunker outfeed auger, a chip transfer auger, and a wood chip boiler stoker (boiler feed unit). The flue gases in the boiler are drawn through the boiler by an induced draft fan at the boiler flue gas outlet. Exhaust gases are passed through a mechanical cyclone scrubber unit to recover ash and particulate matter, and up the chimney.

Low pressure steam, generated by the wood boiler, is conveyed to the various heating loads by means of an insulated underground pipeline. Heat is delivered in the client buildings by means of a heat exchanger added to the current heating system in place in each building. The existing heating systems are retained in place to serve as back-up heating systems. Condensate created in the heat exchangers is returned to the central boiler plant through an underground insulated flow line. The steam flow lines and the condensate return line are separately insulated and packaged in a single conduit. The piping system is manufactured by Ricwell. A brochure on the piping syste is enclosed.

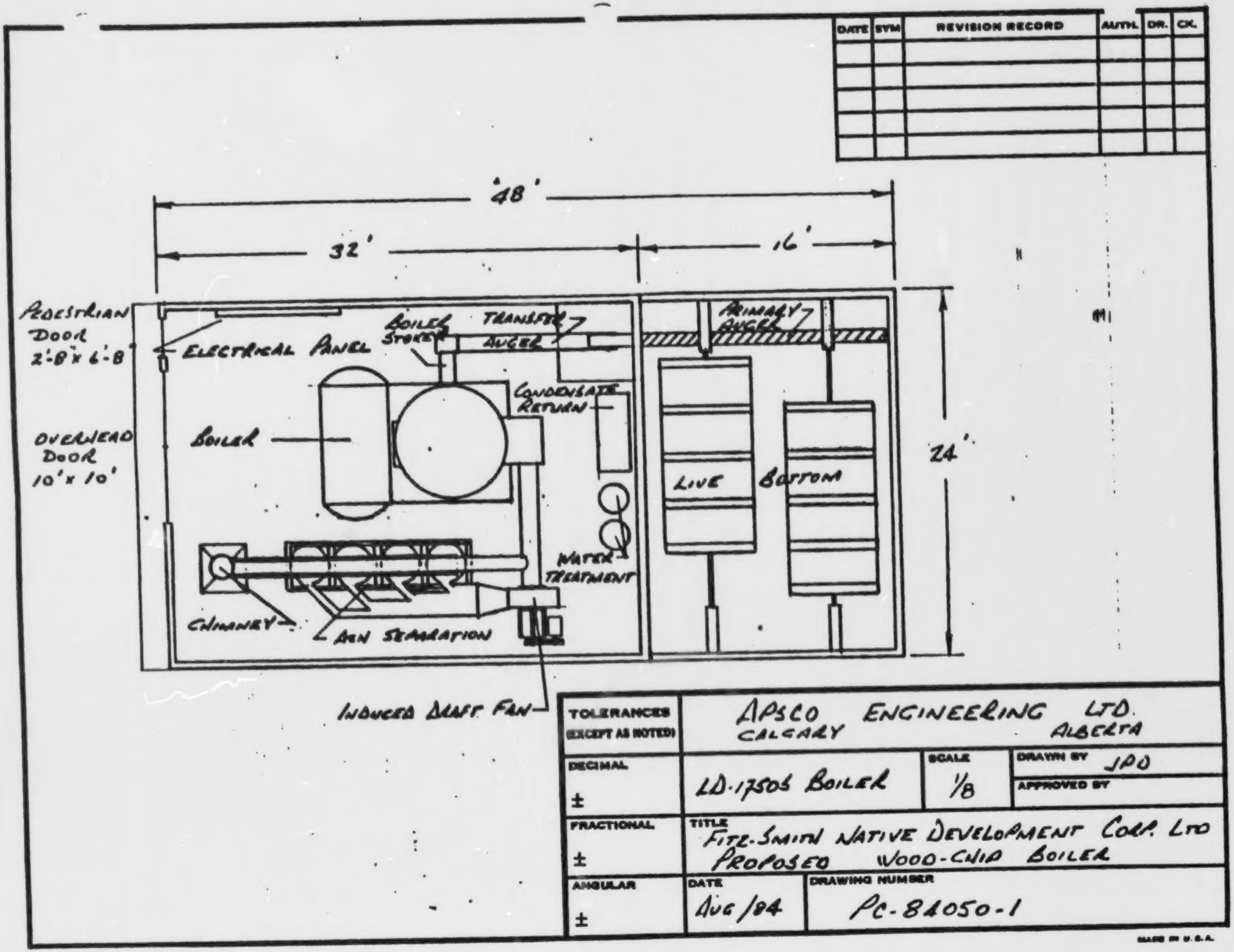
The boiler plant equipment will be housed in a pre-engineered metal exterior clad building, erected on a concrete foundation. The building is estimated to be 24' x 48" in plan dimensions, with an 18 ft. sidewall height and a 30 degree pitch roof. The structure of the building is conventional steel "I-beam" and roof joist with a center truss. R-12 fiberglass insulation with foil backing is applied to the walls and roof.

Land ownership in the downtown core is a consideration to boiler plant placement and distribution line routing. In reference to the town lot map in Figure 2.1/1(b), the Town records indicate the following details of ownership.

Property		Owner
Plan	50787	Pinecrest Hotel
	50573	Pinecrest Hotel
	50894	Hudson's Bay Company
Parcel B:		GNWT, except for McDougall Road frontage leased to NW Tel and to a commercial business.
Lot	818	GNWT
	817	Liquor Store (GNWT)
	811	Private Dwelling
	812-816	Federal Government
	855	Anglican Church
	856	Pelican Rapids Inn
	164	Pelican Rapids Inn
	165	John Vogt
	166	Winerack Building (Don Webb)

Negotiation with some of these property owners will be necessary to enable pipeline crossing of their property. The insulated lines are typically trenched to a depth of .75 - 1.5 metres.

The construction of a central wood boiler plant has to be consistent with Town Zoning Bylaws. At the moment this portion of town is zoned as TC-Town Core. Under this designation, the use of land for "utility" distribution is a "conditional use" subject to Town Council approval. The word utility was not defined in detail in the bylaw, but would conceivably include a heat energy utility system, according to the Town Secretary/Manager. "Conditional use" dictates that the council must specifically consider and approve the use of the land for this project.


DATE
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AUTH.
DR.
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48'
32'
16'
24'
PEDESTRIAN DOOR 2'-8" x 6'-8"
ELECTRICAL PANEL
BOILER STOKER
TRANSFER AUGER
PRIMARY AUGER
OVERHEAD DOOR 10' x 10'
BOILER
CONDENSATE RETURN
LIVE BOTTOM
WATER TREATMENT
CHIMNEY
ASH SEPARATION
INDUCED DRAFT FAN
TOLERANCES (EXCEPT AS NOTED)
DECIMAL ±
FRACTIONAL ±
ANGULAR ±
APSCO ENGINEERING LTD.
CALGARY ALBERTA
LD-1750S BOILER
SCALE 1/8
DRAWN BY JPD
APPROVED BY
TITLE FITZ-SMITH NATIVE DEVELOPMENT CORP. LTD
PROPOSED WOOD-CHIP BOILER
DATE AUG /84
DRAWING NUMBER PC-84050-1
MADE IN U.S.A.

VIF

SPECIAL BOILER FOR COMBUSTION OF SOLID FUELS AND WASTE

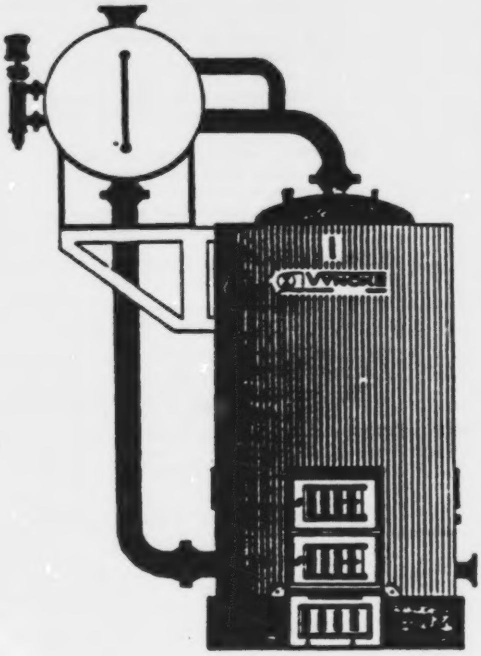
Medium : low pressure steam, hot water
Output : 1 250 000 - 3 000 000 kcal/h
1 450 - 3 500 kW

RANGE LD 1 250 - 3 000

ENERGY FROM ...

Wood, paper, cardboard, packing materials, fabrics, bark, coal, agro-waste (bagasse, palmfruit- and coconutwaste, soja ...) ...

Vertical three draught boiler, with a very spacious furnace built, as it were, around the flame, with a seperate steamdrum connected with the boiler by means of circulation pipes.



Characteristics :

1. MAXIMUM HEAT TRANSFER

Due mainly to the radiation in the vertical furnace, in which the flame burns completely without coming into contact with the ' cold' wall of the boiler.

Thanks to the sensibly chosen velocity of the flue gases in the vertical convection part, fly ash is removed.

Also, due to the result of good insulation of 50 mm rockwool, covered by lacquered steel plate.

2. OPTIMUM COMBUSTION

As a result of the seperate regulation of primary and secondary air and thorough mixing of the air, with the fuel and combustion gases.

Also, due to the induced draught fan which keeps the under pressure constant, even with varying quantity of fuel. Controlled manually or automatically by means of the flue gas valve.

As a result of the fire - proof lining which is sufficient and yet as limited as possible thereby allowing the combustion temperature to maintain the required level.

3. LONG LIFE

Solid construction - made of quality steel boiler plate in accordance with DIN / NBN / ASME / BS / ... standards.

Hydraulic test to 1,5 times the maximum working pressure.

The watercooled reversing chamber avoids a fragile refractory lining.

The optimum watercirculation results in an even dilatation of the material.

4. GREAT ACCESSIBILITY FOR CONTROL AND MAINTENANCE

The large double filling door allows access to the furnace and the grate.

The reversing chambers are accessible via an adapted socle and via removable inspection covers above and beneath.

5. SAFE AND SIMPLE CONTROL

The furnace being subject to a negative pressure prevents back-fire.

The regulating and safety pressure switches determine respectively the desired and the maximum steampressure. The safety relief valves protect against too high pressure.

A float switch checks the water level. Visual control is done with a sight glass and an electrode is fitted as an additional safety device.

6. FULLY ADAPTABLE FOR USE WITH THE "VIMATIC" STOKING SYSTEMS FOR ALL KINDS OF SOLID WASTE AND FUELS

- SSK : screw stoking system
- PSS : tangential blow-insystem
- VVH : underground pre-furnace with stepped grate
- RWR : pneumatic pre-drying stoking system
- DRS : rotary grate
- KSK : stoking system with screw for coal
- DTB : dosing feed belt
- DHC : hydraulic compacting stoking system
- DSX : pre-drying system with feed belt
- WBS : fluid bed stoking system
- light fuel oil or natural gas burner

VYNCKE
LOOKING AHEAD FOR ENERGY

Revision
Replaced by

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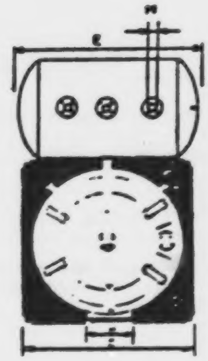
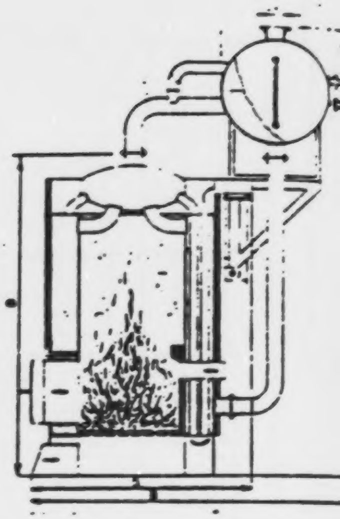
Due to product improvement specifications may change without notice.

- insulated pressure vessel
- insulated steam drum
- risertubes and downcomers between pressure vessel and steamdrum
- furnace with flat refractory grate
- 2 section manual charging doors
- adjustable secondary air intake
- ashdoor with primary air intake
- cleaning doors on upper and lower reversing chamber
- flue gas damper
- provisions on the pressure vessel for the connection of feedwaterline, hotwater return, blow-off line, underpressure gange, flue gas ducting.
- provisions on the steamdrum for the connection of steamsupply, hot watersupply, safety relief valves, pressure switches, steampressure gauge, sight glass, water level regulator and electrode.
- 1 steam supply gate valve
- 2 hot water valves (supply and return gate)
- 1 boiler blow-off valve
- 1, 2 or 3 safety relief valves
- 1 sight glass
- 1 sight glass
- 1 pressure gauge with check-flange
- 2 temperature gauges (for mounting on hot water supply and return lines)
- automatic feedwater regulation :
    - water level regulation
    - magnetic valve
    - filter, non-return and gate valve
- cleaning tools

A magnetic valve can only be used when pressurised water is available. When this is not the case, a feedwaterpump should be installed.





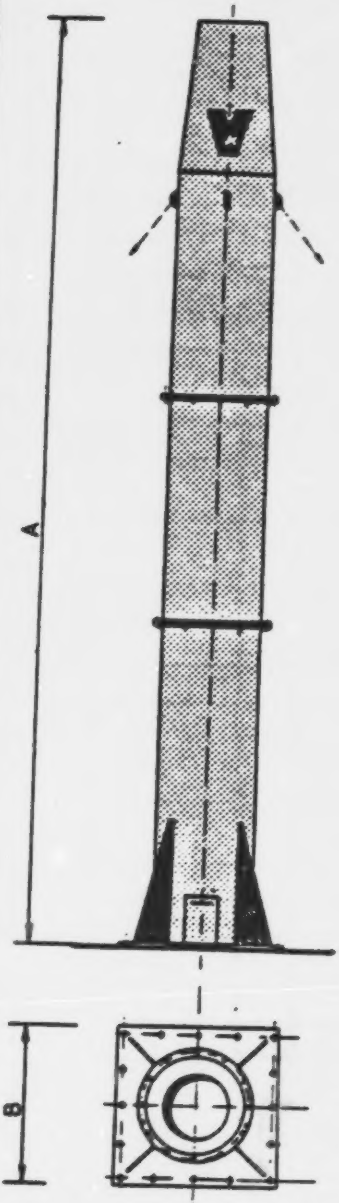
This enumeration concerns the VIF-standard arrangement, whi adapted for manual feeding. The special boiler characteristic automatic feeding are described together with the related stoking systems.

TECHNICAL DATA							
VIF MODEL LD		1 250	1 500	1 750	2 000	2 500	3 000
NOMINAL OUTPUT *	Gcal/h kW	1,25 1 450	1,50 1 740	1,75 2 040	2,00 2 330	2,50 2 910	3,00 3 490
DIMENSIONS (mm)	A B C D E ØF G	5 200 3 300 2 070 3 800 2 500 1 100 2 550	5 500 3 600 2 250 3 950 2 600 1 300 2 750	5 600 3 800 2 450 3 950 3 100 1 300 2 980	5 900 3 950 2 450 4 250 3 100 1 300 3 000	6 200 4 350 2 750 4 400 3 200 1 500 3 350	6 300 4 550 2 950 4 500 3 200 1 500 3 650
FIRE DOORS (mm)	H I	580 750	580 750	700 900	700 900	700 900	700 900
GAS OUTLET (mm)	ØJ	380	400	430	450	500	550
STEAM SUPPLY NOMINAL PIPE SIZE (mm)	ØK	150	150	200	200	250	250
FEEDWATER NOMINAL PIPE SIZE (mm)	ØL	25	25	25	32	32	32
WATER SUPPLY AND RETURN NOMINAL PIPE SIZE	ØM	125	150	200	200	200	250
BLOW-OFF NOMINAL PIPE SIZE	ØN	50	50	50	50	50	50
MINIMUM HEIGHT BOILERHOUSE (mm)		6 200	6 500	6 600	6 900	7 200	7 300
BOILERWEIGHT DRY (kg)		8 000	9 000	12 000	13 000	17 000	20 000
WATER CAPACITY (l)		4 000	5 600	7 000	7 600	9 000	10 500
MAXIMUM FUEL BURNED	Wood at Hu = 3 773 kcal/kg = 15 796 kJ/kg η = 75 % (kg/h)	442	530	618	707	883	1 060
	Light fuel at Hu = 10 031 cal/kg = 41 997 kJ/kg η = 85 % (l/h)	166	200	233	266	333	400

* The nominal output is calculated for fuels with a minimum heating value (Hu) of 3 773 kcal/kg (e.g. wood with max. m.c. of 16 % on bone dry basis)

MAXIMUM STEAMPRESSURE	GERMAN AND AMERICAN STANDARDS (ASME) : 1 bar OTHER STANDARDS : 0,5 bar
MAXIMUM WATERTEMPERATURE	GERMAN AND AMERICAN STANDARDS (ASME) : 121 °C OTHER STANDARDS 110 °C

STACK



STACK :

Steel stack with guy ropes for mounting after a VIF-boiler.
Standard heights 7 , 13, 19, 25 m

INCLUDING :

- mild steel stack with flanges every 6 m
- conical top
- clean-out door
- base plate
- flue gas inlet with flange
- guy ropes

OPTIONAL :

- "Carten"-steel
- insulation, covered with an aluminium jacket

SPECIFICATIONS						
BOILER MODEL VIF		300 500	750 1 500	1 750 3 000	4 000 6 000	7 000 9 000
STACKDIAMETER (mm)		12 320	18 480	26 640	36 900	44 1 100
BASE PLATE B (mm)		500	750	1 000	1 500	1 750
WEIGHT (kg)	A = 7 m	315	455	595	875	1 015
	A = 13 m	585	845	1 105	1 625	1 885
	A = 19m	855	1 235	1 615	2 375	2 755
	A = 25 m	1 125	1 625	2 125	3 125	3 625

VYNCKE

LOOKING AHEAD FOR ENERGY

Revision
Replaced by

Due to product improvement specifications may change without notice.

25 . 05 . 1981

VME 06.01

CONTROLS

Prewired in a NEMA 12 Enclosure
Including:

I. REGULATION AND SAFETY CONTROLS							
		TYPE					
	DESCRIPTION	Mini		Industrial			
		WW	LD	WW	LD	HD	TO
MEDIUM	Temperature Control	•		•			•
	Safety Temperature Control	•		•			•
	Pressure Control		•		•	•	
	Safety Pressure Control		•		•	•	
	Pressure Control For Protection Against Low Water Conditions	•		•			•
	Water Level Control, Two (2) Electrical, Thermostatic		•		•	•	
	Flow Control						•
COMBUSTION	Flue Gas Thermometer	•	•				
	Flue Gas Temperature Control And Safety Control			•	•	•	•
	Furnace Pressure Gauge	•	•				
	Furnace Pressure Control Through Servomotor (Modulating)			•	•	•	•
	System Purge Control	•	•	•	•	•	•
	Minimum Fire Timer and Control	•	•	•	•	•	•
II. MOTOR CONTROLS							
Magnetic Starters and Pushbuttons		•	•	•	•	•	•

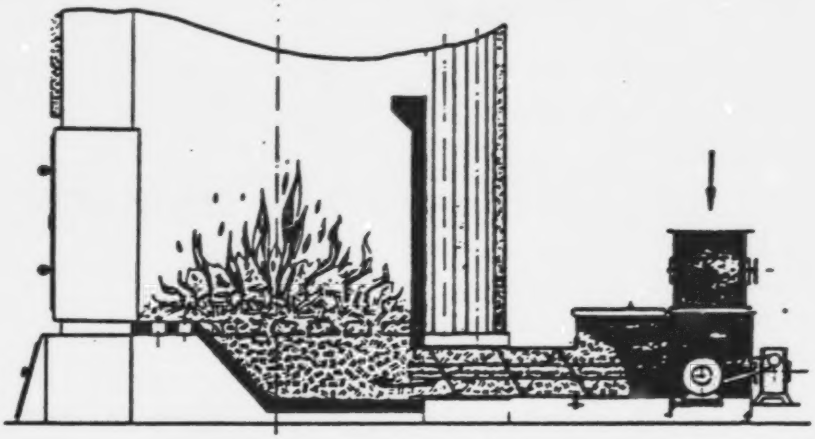
As the steamconsumption normally is not very important, generally no special characteristics of the feeding water are required. Nevertheless, the water has to be clear, colourless and free of suspended materials and mechanical impurities.

However it always has to be recommended and even it is obligatory in case of a great steam consumption to use water with the following characteristics.

Total hardness	°dH	: max. 0,05
Salts	(mg/l)	: max. 500
Oxygen O2	(mg/l)	: max. 0,1
Chemically bound carbondioxide (CO2)	(mg/l)	: max. 0,25
Free CO2	(mg/l)	: 0
Oil	(mg/l)	: max. 5
Permanganate consumption (KMnO4)	(mg/l)	: if possible max. 10
pH (at 25°C)		: 8,5 to 9,5

VIMATIC
ssk

FOR GRANULAR WASTE
AUTOMATIC FEEDING SYSTEM



The Vimatic SSK has been designed to automatically feed granular combustible employing the underfeed stoking principle.

The SSK can burn many types of biomass fuels with characteristics as follows :

- Maximum size of particle should not exceed 10 x 15 x 20 mm
- Maximum moisture content 50 % measured on the bone dry basis.
- Maximum Ash Content 0,5 %

1. PRINCIPLE OF COMBUSTION :

The SSK receives the biomass fuel from the metering system. The SSK by means of an Archimedian Screw feeds the biomass fuel into a U-shaped trough at the bottom of the boiler. This trough is lined with refractory concrete and forms the bottom of the boiler furnace. Primary air holes are located around this trough which supply the necessary oxygen for the proper combustion of the fuel. Because of the construction and the underfeed principle only the top layer of the fuel is consumed. As the fuel is slowly pushed upward, it is gradually heated. Near the surface of the fuel bed, the temperature rises to the point where gasification occurs. This gas is mixed with the air above the fuel bed and ignites because of the high temperature. Finally the carbonized fuel itself also comes into contact with oxygen at the surface and will be consumed. The addition of secondary air inlets above the fuel bed insures proper combustion.

2. ADVANTAGES OF THE UNDERFEED STOKING SYSTEM

Uniform Combustion :

Since the fuel is supplied from beneath the flame, very few unburned particles are carried along with the flue gas stream.

Quality combustion :

Because of the gradual heating of the fuel, the moisture content, the size of the fuel, and the density of the fuel do not greatly influence the quality of the combustion.

Independent Control of the Fuel to Air Ratio :

It is extremely important that the amount of primary air, secondary air and fuel can be controlled independently. Without this proper mix, proper combustion is impossible. With the underfeed stoking principle, primary air, secondary air and fuel can all be controlled seperately.

Automatic Reignition Without Auxilary Fuel :

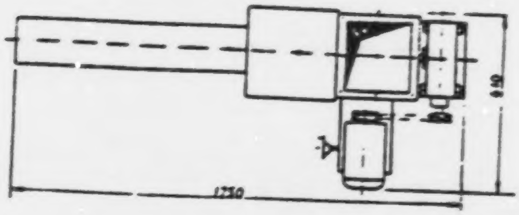
The underfeed stoking principle makes reignition without auxilary fuel possible even after a relatively long shutdown period. During long periods of boiler shut down, the fuel bed will insulate itself with a very thin layer of ash. This keeps the fuel bed warm enough for automatic reignition by simpl supplying a very small quantity of fuel which breaks open the fuel bed.
A hold fire timer can be provided in the control panel for automatic reignition after a very long shut-down period. (e.g. week-ends). There should remain a very small energy demand.

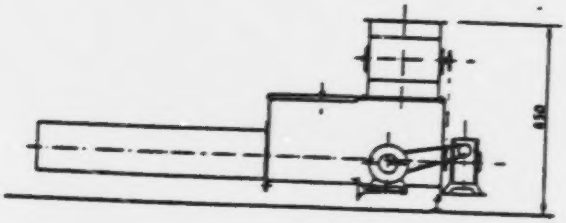
3. SPECIAL CHARACTERISTICS

The Vimatic SSK has been designed to withstand severe working conditions.

The first section of the screw is made of high temperature stee in order to resist the radiant heat from the combustion chamber.
The screw is isolated from the metering system by means of air tight rotary valve which protects against fire blow back.
The screw runs in two ball bearings for smooth operation. Th tube in which the screw operates is protected by dual thermostatic sensors which protects against high temperature situation

VYNCKE	Revision Replaced by	25 . 05 . 1981
LOOKING AHEAD FOR ENERGY	Due to product improvement specifications may change without notice.	VME 02.01





THE VIMATIC SSK INCLUDES

- refractory grate with feed trough
- underfeed stoker :
    - archimedian screw with section made of high temperature steel
    - screw tube
    - external roller bearing and internal friction bearing
    - rotary valve
    - E-motor with : gear reducer
      beltransmission between motor and screw
      chaintransmission between motor and rotary valve
- thermostatic protection :
    - dual spray line
    - pressurised water tank with valve, no-return valve, pressure gauge
    - magnetic valve with thermostat
    - valve with capillary and thermostat

TECHNICAL DATA

- dimensions : see drawing
  minimal distance between boiler and boiler-housewall : 2 000 mm
- motorpower boilersize 300 - 2 000 : 1,5 kW
  boilersize 2 500 - 3 000 : 2,2 kW
- expeditiondata : weight : 150 kg

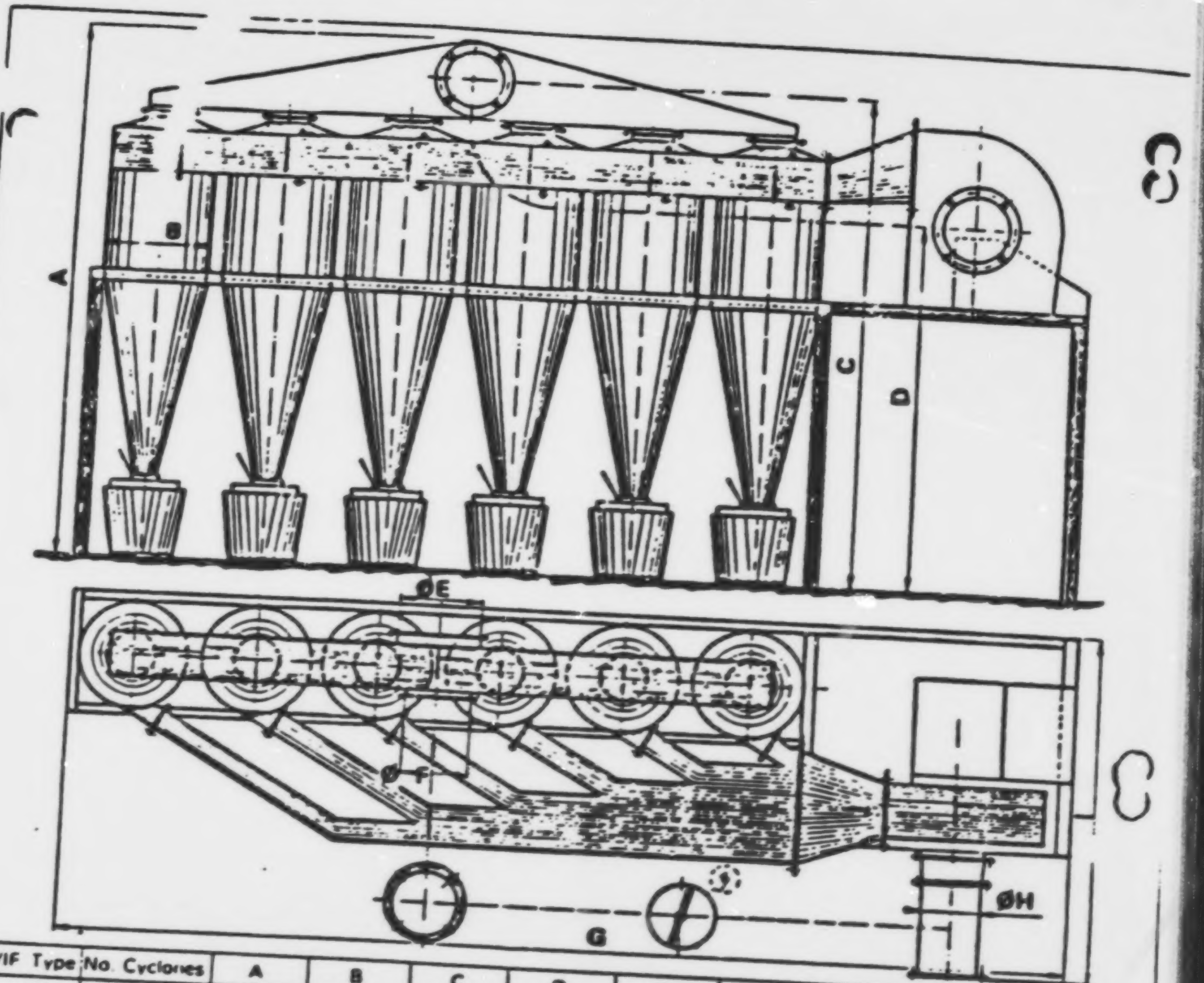
MULTI-300

Ash Separation System

Including:

- Cyclone (s)
- Fan including motor and drive
- Ash reinjection system
- Structural support
- Ash bucket (s)
- By-pass ducting including servomotor for the Industrial Series
- Manifold ducting
- Flue gas ducting to boiler not to exceed 30'

Reference Drawing: No. V53



VIF Type	No. Cyclones	A	B	C	D	E	F	G	H	I
150	1	83 5/8	19-5/8	77-3/4	▨	6	6	58-1/4	6	26
250	1	95-7/8	24-7/8	90	▨	6	6	67-1/8	6	31-1/8
400	1	104-3/4	31-1/2	98-7/8	▨	8	6	73-7/8	8	37-3/4
500 550	1	150	31-1/2	141-3/4	111-1/4	11	9	79-3/4	9	59
700 750	2	154-3/8	31-1/2	141-3/4	107-1/4	14	11	117 1/2	11	78 3/4
1000	2	157 1/2	31-1/2	141-3/4	107-1/4	17	14	117-1/2	14	70-7/8
1250	3	156 1/4	31-1/2	141-3/4	107 5/8	18	15	170 5/8	15	88-5/8
1500	3	158-1/4	31-1/2	141-3/4	107 5/8	20	16	170 5/8	16	88 5/8
1750	4	160 1/4	31-1/2	148-1/2	107-5/8	22	17	206-1/8	17	92-1/2
2000	4	160 1/4	31-1/2	148-1/2	107 5/8	23	18	206-1/8	18	92 1/2
2500	5	162 1/4	31-1/2	150-3/8	111	24	20	254	20	98-3/8
3000	6	187	31 1/2	173-1/4	118 1/8	25	22	308	22	118-1

[illegible] All dimensions are in inches [illegible]

RICWIL Prefabricated Insulated Piping Systems

- *DRAINABLE*
- *DRYABLE*
- *TESTABLE*

ANVIL™ RICWIL®

ADVANTAGES OF RICWIL INSULATED PIPING SYSTEMS

- Drainable, dryable, testable
- Uniform quality, welders are qualified under code for pressure piping ANSI B31.1.0
- Rigid conformance to specifications
- Airtight — watertight
- Inherent conduit strength permits shallow trenches
- Factory prefabricated for efficient field installation
- One order — Complete System
- Pre-determined costs
- Factory guidance of installation
- Factory certification of installation
- Meets labor and code requirements
- Approved by Department of Defense Tri-Service and other governmental agencies
- Most experienced supplier
- 4 plants guard against production interruptions

RICWIL PREFABRICATION

A Scientific Technique

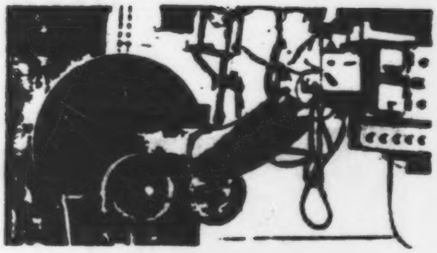
RICWIL, Incorporated, represents the modern scientific approach to the problem of insulating and protecting pipe distribution systems. RICWIL Insulated Piping is precision built on a mass production basis by expert workers in factories designed and equipped for this exclusive purpose.

RICWIL Units are engineered in correct basic design. All standardized parts are precision machine-made. RICWIL, Incorporated, supplies every type of unit, accessory and fitting, in the form of easily manipulated, job-handled segments, entirely prefabricated. The system is delivered complete and ready to install.

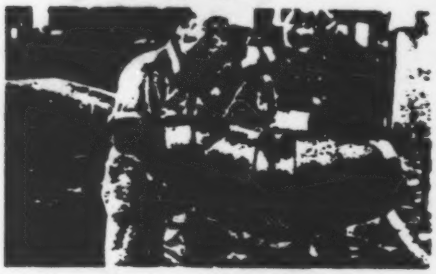
The construction of RICWIL systems conforms with working practice of trade unions in the field. Full cooperation with architects and engineers such as: complete drawings, installation literature, field service instructor and factory certification are available, if required.

Installation time and system cost to contractor and user are reduced to a minimum due to efficient factory fabrication, and an assured predetermined price and shipping date.

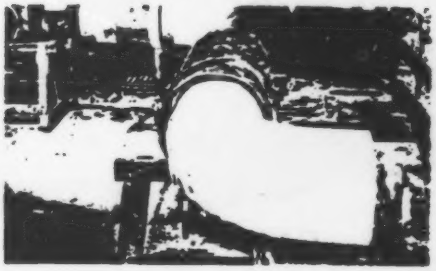
The success of this prefabricated system is proved by installations totaling thousands of miles of RICWIL Units rendering highly satisfactory and dependable service with minimum upkeep and maintenance.



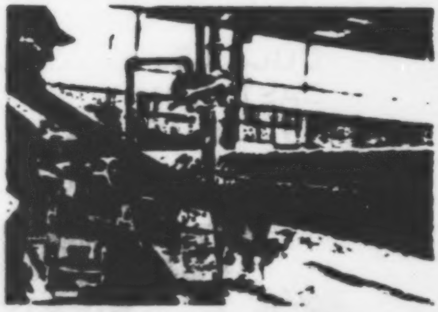
Welding 90° elbow fitting with submerged arc welder.



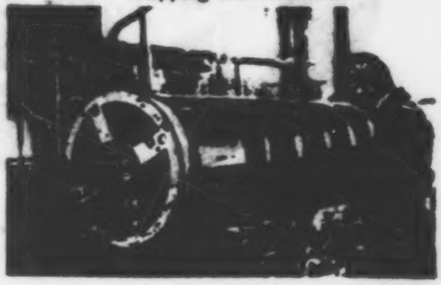
Welding mitered conduit for expansion loop.

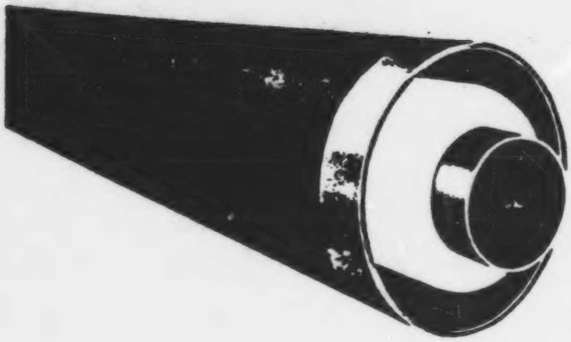


Insulation of pipe elbow.



Skilled workmen, with specialized machines, coating and tension wrapping RICWIL units.





Types of RICWIL CONDUIT SYSTEMS

RICWIL, Incorporated SPECIALIZES in the prefabrication of insulated piping systems. The types of RICWIL Conduit Systems listed below are the result of more than a half-century of experience, and are engineered to meet any subsoil conditions.

IMPERIAL*

RICWIL Imperial* Conduit is made of 10 ga. (min.) spiral welded steel, coated with an unmodified catalytic epoxy coating. Because of its inert nature, this coating has excellent corrosion resistance to any soil condition. For details see pages 10-11.

GALVA-FLEX*

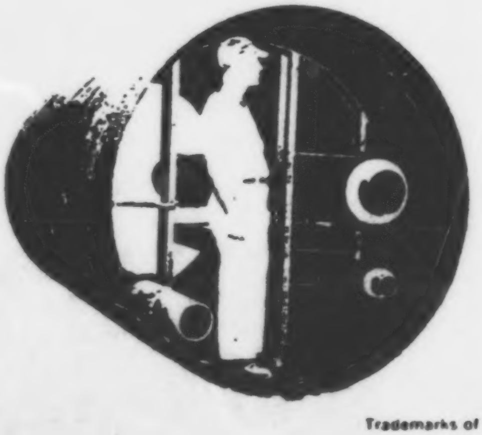
RICWIL Galva-Flex* Conduit is made of 16 ga. spirally corrugated steel with 10 ga. end collars, hot dipped galvanized after fabrication and machine coated with high melting point asphalt, an interposed layer of fiberglass screen, and an outer wrapping of fiberglass reinforced asphalt-impregnated pipe line felt. For details see pages 12-13.

GALVA-GARD*

RICWIL Galva-Gard* Conduit is made of 10 ga. spiral welded steel, galvanized and machine coated with a high melting point asphalt, an interposed layer of fiberglass screen, and an outer wrapping of fiberglass reinforced asphalt-impregnated pipe line felt. For details see pages 14-15.

DUCTILE CAST IRON

RICWIL Ductile Cast Iron Conduit is a heavy duty outside housing for insulated pipe.



UTILIDOR CONDUIT

RICWIL Prefabricated Utilidors are designed for housing all utilities economically in a common conduit. See Utilidor Brochure UT-43.

*Trademarks of RICWIL, INC

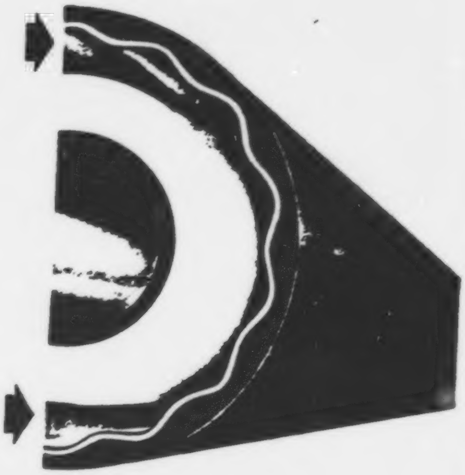
ALL RICWIL CONDUITS CAN BE USED WITH ANY PIPING SYSTEM

Any RICWIL Conduit — Imperial*, Galva-Flex*, Galva-Gard*, or Ductile Cast Iron — can be used for all types of insulated pipe installations. The type of conduit to be installed is determined by soil conditions, live and dead loads, cost factors, etc.

Each RICWIL Conduit is designed and engineered to exact specifications. Their adaptability allows greater savings and efficiency in moving steam, hot water, refrigerants and viscous fluids.

*Trademarks of RICWIL, INC.

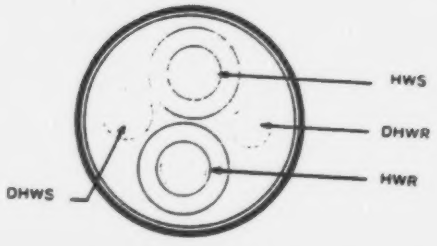
Dead Air Space — A Feature of All RICWIL SYSTEMS

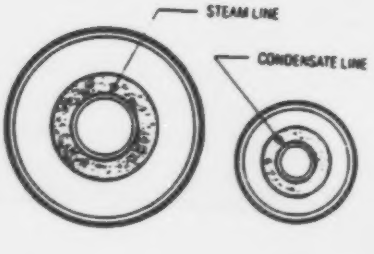


There are reasons this air space is designed into every RICWIL Insulated Piping System.

It plays an important part in helping to maintain the desired temperature with a minimum of heat loss. It functions like the air space in a double-pane window and increases the insulation efficiency.

If water inadvertently enters the conduit air space between the insulation and the conduit wall, the system can be drained and air can be force-circulated through the space to dry the insulation, and thus maintain its maximum efficiency over the years.



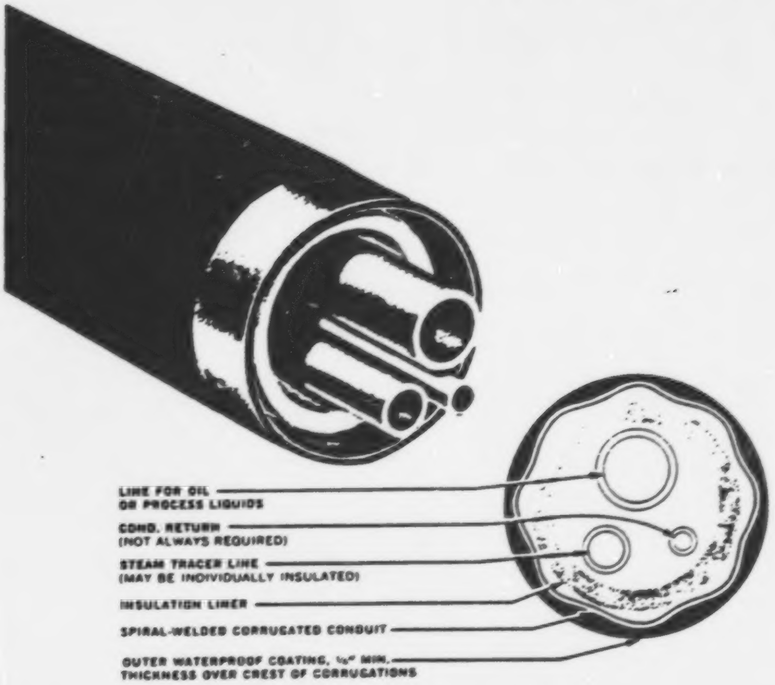


RICWIL INDIVIDUALLY INSULATED PIPES FOR STEAM, HOT WATER, OR OIL

With this type of system, each pipe may be individually insulated or left bare, as may be desired. The pipes may be of any specified materials or combinations thereof.

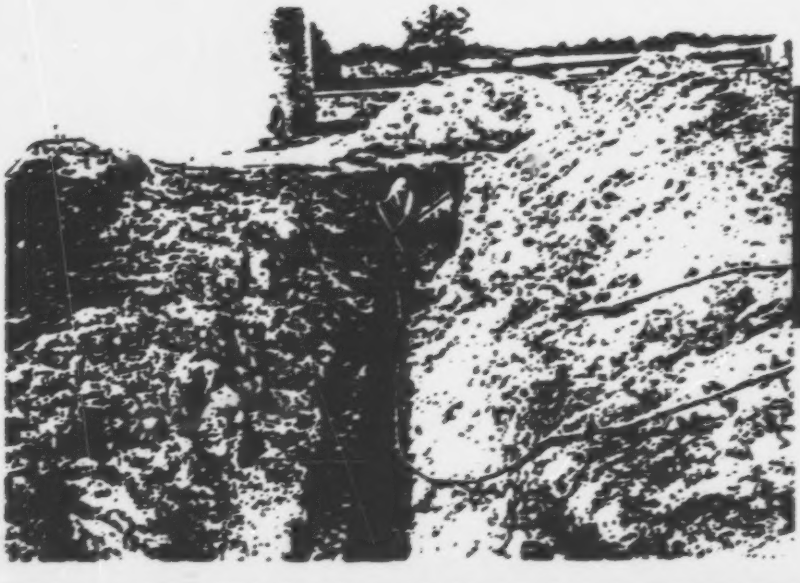
RICWIL

INSULATED NESTED PIPE UNITS...*for Oil, Other Viscous Fluids, Process Liquids*


LINE FOR OIL
OR PROCESS LIQUIDS
COND. RETURN
(NOT ALWAYS REQUIRED)
STEAM TRACER LINE
(MAY BE INDIVIDUALLY INSULATED)
INSULATION LINER
SPIRAL-WELDED CORRUGATED CONDUIT
OUTER WATERPROOF COATING, 1/16" MIN.
THICKNESS OVER CREST OF CORRUGATIONS

In this type of RICWIL Insulated Pipe Unit, pipes are nested inside an insulation liner so that they are insulated from the exterior but not from each other. Any desired temperature can thus be maintained in the system with tracer lines of steam, hot water, brine or any other heating or cooling medium; liquid or gas. The Uniline Insulation Liner is made of highly efficient insulating material, in any specified thickness. Individual pipes may be insulated, if required.

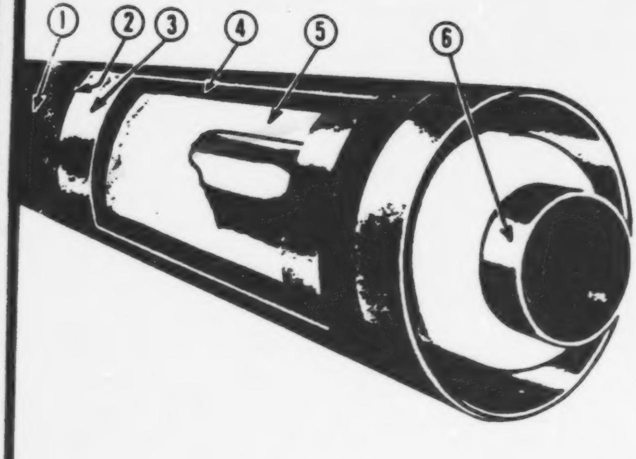
VISCOUS FLUIDS of many varied types require insulated piping of exacting standards and high efficiency. Oil refineries, chemical plants, asphalt manufacturers, food processors, textile and paper mills, leather goods makers and distilleries are among the many who specify RICWIL Insulated Piping Systems.



A typical application of nested type piping system is shown at left. The nested oil and steam tracer pipes are surrounded with insulation and protected by an air tested RICWIL Conduit.

GALVA-GARD*

SMOOTHWALL
Galvanized Conduit



1. An outer wrap of asphalt impregnated fiberglass reinforced pipe line felt applied spirally under tension.
2. A machine coating of high melting point asphalt with an interposed layer of fiberglass screen.
3. 10 gauge galvanized spiral welded conduit.
4. Air space between conduit and insulation.
5. Insulation as specified.
6. Pipe as specified.

RICWIL Galva-Gard* Conduit is hot dip galvanized, both inside and outside, in the most modern galvanizing plant in operation today. The conduit is further protected by multiple machine applications of high melting point asphalt with an interposed layer of fiberglass screen and one final outer wrap of asphalt impregnated fiberglass reinforced pipe line felt applied spirally under tension.

Outside zinc coating is removed from terminal ends of units to provide a black steel surface on which the field connector bands will be welded.

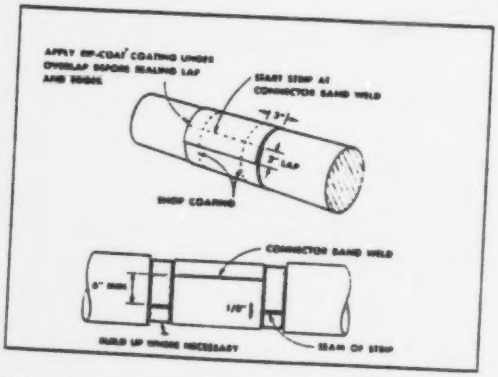
A single pipe, or any combination of multiple pipes, is accommodated in the conduit as required. Insulation type and thickness, in accordance with project specifications, is factory applied.

Pipe is supported by sturdy thermal insulating support-guides at regular intervals. Pipe is free to expand or contract in a longitudinal or lateral direction without wear or injury to the insulation or conduit.

The entire system is factory fabricated in 20′ or 39′ lengths as required. All accessories such as expansion loops, elbows, tees, anchors, and end seals are completely factory fabricated and shipped to the job site ready for immediate installation. The only field welding required is the connecting of straight sections of pipe and conduit to accessories and each other.

Note: 39′ length not applicable if largest size pipe in conduit does not exceed 2" dia.

FIELD JOINT COATING PROCEDURE FOR ALL RICWIL GALVANIZED STEEL CONDUIT


APPLY RIP-COAT* COATING UNDER OVERLAP BEFORE SEALING LAP AND EDGES
START STRIP AT CONNECTOR BAND WELD
2" LAP
SHOP COATING
CONNECTOR BAND WELD
6" MIN
1/8"
BUILD UP WHERE NECESSARY
SEAM OF STRIP

r complete field joint coating procedures see Installation Manual

Apply Rip-Coat Coating* evenly to all metal surfaces and lap about 1" over the factory coating and allow to dry. Fill up all gaps, seams and crevices with Rip-Coat Coating* and Rip-Coat Blanket* between connector band and factory coating.

Liberally coat entire field joint area on one side of Rip-Coat Blanket* with Rip-Coat Coating*, then stretch and press blanket firmly into place.

GALVA-GARD* Smoothwall Galvanized Conduit Systems

All steam, condensate returns, drip and discharge, hot water, oil or process piping, to be installed overhead or underground between manholes and buildings or between buildings, as shown on plans, shall be installed in RICWIL Galva-Gard* Galvanized Prefabricated Insulated Pipe Conduit, with all necessary fittings, anchors, expansion loops and conduit accessories, etc., as hereinafter specified.

1. CONDUIT — Conduit shall be 10-gauge smoothwall hot dipped galvanized steel having all outside surfaces of the conduit (except for overhead lines) machine-coated with high melting point asphalt to a minimum thickness of 1/16", with an interposed layer of fiberglass screen plus one final outer wrap of asphalt impregnated, fiberglass reinforced, pipe line felt applied spirally under tension.

Conduit closures shall be furnished with the conduit at a ratio of one closure for each fabricated item or length. Closures shall consist of 10 gauge steel suitably rust-proofed and in cylindrical form with a single horizontal split and shall be field welded over adjacent units. After test (paragraph 7) all exposed closures shall be covered in the field with Rip-Coat Coating* and Rip-Coat Blanket*. All materials and insulation required for complete field closure shall be furnished with the conduit.

2. PIPE AND PIPE SUPPORT-GUIDES — All piping in conduit shall be as hereinafter specified for the service required. All ferrous pipe field joints shall be welded by competent mechanics and hammer tested under hydrostatic pressure of 250 psig or one and one-half times the design pressure, whichever is greater. Concealed pipe welds in prefabricated conduit fittings shall be factory tested the same as specified for field welds prior to assembly.

Piping shall be suitably spaced and supported in conduit by specially designed full round insulating support-guides and shall permit the pipe to expand and/or contract freely without stress or wear on the pipe or insulation as well as provide for drainage and free air circulation.

3. EXPANSION LOOPS, ELLS AND TEES — Prefabricated ells, loops and tees shall be furnished and installed where shown on plans and shall consist of pipe, insulation, and conduit conforming to the same specification as hereinbefore specified for straight runs.

Expansion loops shall be of proper design in accordance with stress limits indicated by A.S.M.E. Code for pressure piping, District Heating Section. Loop piping shall be installed in conduit suitably sized to handle indicated pipe movement.

ALTERNATE: Where space does not permit the use of loops, expansion joints in manholes or bellows type expansion joints housed in conduit (similar in design to straight run) shall be provided.

4. END SEALS AND GLANDS — Terminal ends of conduits inside manholes, pits, or building walls shall be equipped with end seals consisting of a steel bulk head plate welded to the pipe and conduit. Where there is no anchor within five feet of a terminal end, conduits shall be equipped with gland seals consisting of a packed stuffing box and gland follower mounted on a steel plate welded to end of conduit. End seals or gland seals shall be equipped with drain and vent openings located diametrically opposite on the vertical center line of the mounting plate and shall be shipped to the job site with plugs in place. Terminate all conduits 2" beyond the inside face of manhole or building walls to protect any exposed piping insulation from damp-wall condensation.

5. LEAKPLATES — To provide an effective moisture barrier, conduits shall be equipped with leakplates in building or manhole walls — but only when there is an anchor plate within 5 feet outside the wall. Leakplates shall consist of a steel plate flange 4" larger in outside diameter than the conduit, welded to the conduit only and located in the wall approximately 6" from the end of the conduit. Wall sleeves are recommended where leakplates are not furnished.

6. ANCHORS — Prefabricated plate anchors shall be furnished and installed where shown on plans and shall consist of a steel plate welded to pipe and conduit. The steel plate shall be ⅜" thick for 6⅝" to 10¾" conduit, ½" thick for 12" to 22" conduit and ¾" thick for conduit over 22".

A concrete block shall be cast over the plate and conduit and shall be large enough for firm anchorage into undisturbed trench sidewalls and/or bottom. The concrete block to be at least 30" in length and extend a minimum of 9" beyond the top and bottom of anchor plate.

7. CONDUIT AIR TEST — All field welds at conduit closures shall be tested for leaks before applying Rip-Coat Coating* and Rip-Coat Blanket*. During test all field welds shall be checked with soap suds, and rewelded if necessary until air tight at 15 lbs. pressure.

The contractor shall furnish all necessary equipment and labor to perform the air test, including air compressor, gauges, conduit caps, temporary pipe and connections, etc. and complete the test to the satisfaction of the architect and/or engineer.

8. PIPE INSULATION — All pipe or pipes in conduit, shall be insulated as hereinafter specified.

9. MANUFACTURER'S FIELD INSTALLATION INSTRUCTOR— who is technically qualified to determine whether or not the installation is being made in accordance with the manufacturer's recommendation shall be present during critical periods of installation and test of the system. On completion of the installation, the contractor shall deliver to the owner a certificate from the manufacturer stating that the installation has been made in accordance with the manufacturer's recommendations.

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*Trademark of RICWIL, INC.

6.2 CAPITAL COSTS

The estimated capital costs to supply and install the town core wood boiler facility are assembled in Table 6.2/1. The costs for the boiler equipment and building, installed and commissioned, were secured by a proposal from APSCO Engineering Ltd. for the turnkey manufacture, supply and erection contract. Underground flow line costs were taken to be $120/foot to include the cost of materials and installation labour. The amount is based upon a recent detailed estimation of costs for a similar underground flow line installation in Fort Smith (ref. 4). The estimate was the installed cost of both the insulated low pressure steam line and the insulated condensate return line, in a common conduit. The cost is based upon a 3" or 4" diameter (nominal) Schedule 40 low pressure steam line, and a 2" diameter (nominal) condensate line.

On the advice of the Fitz-Smith Native Development Corporation, the capital cost of land to locate the boiler plant is omitted from the capital cost budget. The land entitlement situation applicable to the Fitz-Smith Native Band, and hence the Corporation, is such that the land may be secured without capital cost to the project.

GNWT Headquarters Building

The heating system tie-in from the wood boiler plant at the headquarters building includes the following equipment and labour. A low pressure steam to water heat exchanger is installed in the return water leg of the existing heating system piping in the main Headquarters Building boiler room. Steam is supplied to the exchanger from the underground supply line running into the building. The condensate created from the steam is collected in a condensate receiver tank and pumped back to the wood boiler plant. Building circulation water is passed through the exchanger to pick up heat and then is passed through the existing boilers. In this fashion, the existing boilers are kept warm, in an operable state, and ready to provide heat on a stand-by basis automatically if the steam supply is interrupted.

The steam supply line is extended through the building to tie into a second heat exchanger, added in the return water leg of the Viking 7.8 b.h.p. boiler in the building "addition". A condensate return line is run from this exchanger back to the condensate receiver in the main boiler room. A liquid flow rate and total flow meter is installed in the condensate discharge line from the main boiler room receiver, and is used as a measure of heat energy supplied to the building, for billing purposes.

A sketch of the tie-in details in the main boiler room is presented in figure 6.2/1.

RCMP Detachment Office

Heat transfer of steam energy into the building heating system is achieved through heat exchanger coils placed in the return air plenums of the existing hot air furnaces. Steam condensed in the coils is collected in a condensate receiver tank and pumped back to the wood boiler plant. A separate room air temperature activated furnace fan control is added to the existing controls to turn on the furnace fans in response to building heat demand.

Planned New Federal Building

The planned new federal building is expected to be equipped with dual hot water boilers and a hot water heat distribution system. Steam energy supplied to the building from the underground distribution system is delivered to the building by means of a l.p. steam-to-water heat exchanger installed in the common cold water return line feeding the two planned oil fired hot water boilers. Water, condensed in the exchanger, is collected in a condensate receiver and pumped back to the wood boiler plant.

The existing oil fired boilers and their controls are retained in an operable state for stand-by service. The tie-in plumbing and control requirements are similar to those indicated in figure 6.2/1.

Pelican Rapids Inn

The existing heating system at the Pelican Rapids Inn is similar to the equipment arrangement in the GNWT Regional Headquarters Building. Two boilers are located at one site (in the basement at the north end of the motel), and a third boiler is located in the south center part of the building.

The steam supply line entering the main boiler room is split into two lines. One line is connected to a steam-to-hot water heat exchanger installed in the main boiler room. The second line is run through the motel sub-floor to the second boiler room and connected to a heat exchanger installed in the cold water return line feeding the existing boiler. Condensate created in this heat exchanger, is piped through a separate condensate return line back into a condensate receiver tank installed in the main boiler room.

The boilers in the main boiler room currently share no common loads and have no common connections. The steam heating system tie in assumes that the return lines for the two boilers are modified and combined into one common line. A single steam-to-water heat exchanger is installed at this point to deliver heat to the existing distribution loops. The existing boilers are kept on "hot-standby" service with their controls operative. The sketch in Figure 6.2/1 also illustrates the salient features of this motel tie-in.

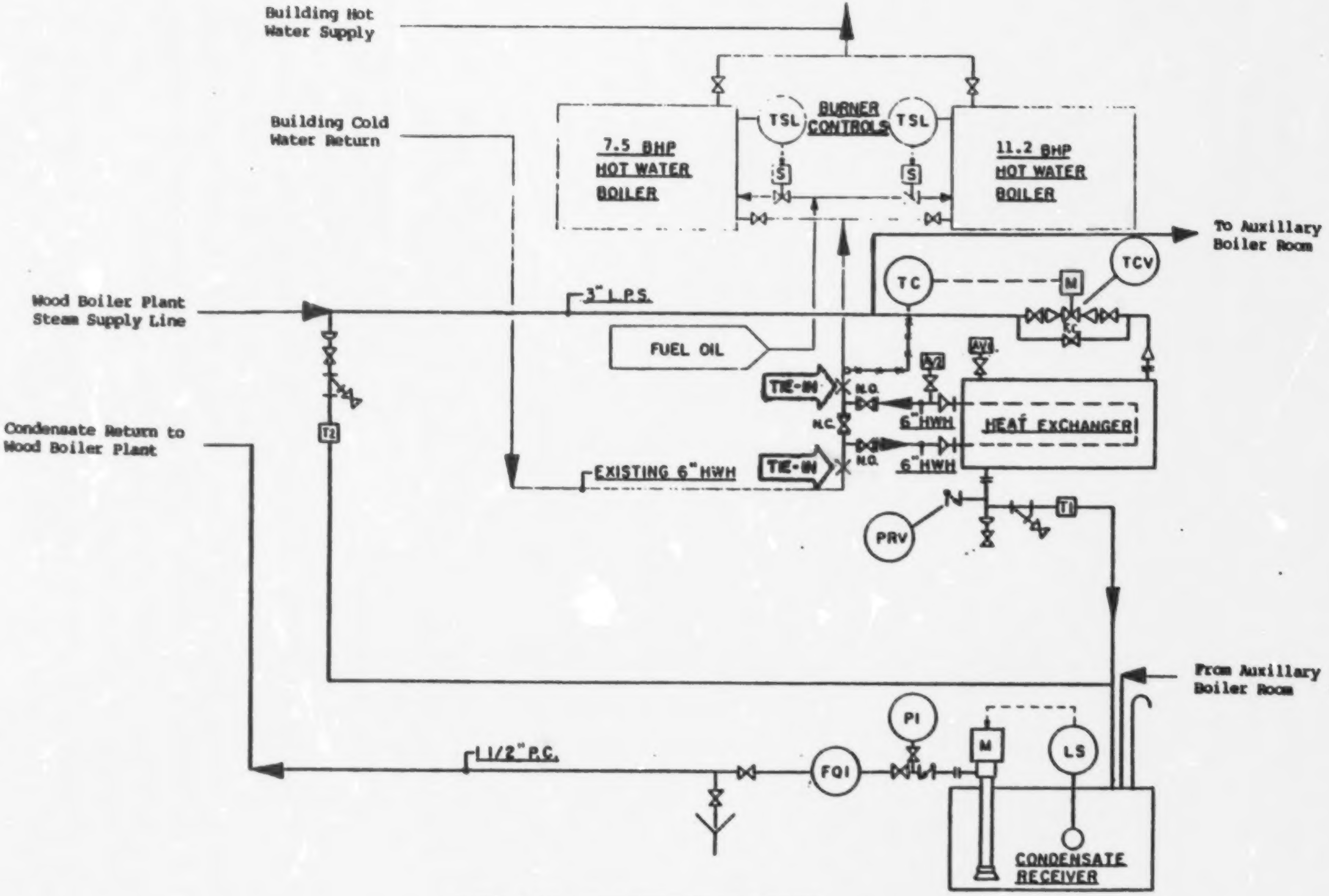

Building Hot
Water Supply
Building Cold
Water Return
7.5 BHP
HOT WATER
BOILER
TSL
BURNER
CONTROLS
TSL
S
S
11.2 BHP
HOT WATER
BOILER
To Auxillary
Boiler Room
TC
M
TCV
N.C.
Wood Boiler Plant
Steam Supply Line
3" L.P.S.
FUEL OIL
AV2
AV1
TIE-IN
N.O.
N.C.
6" HWH
HEAT EXCHANGER
TIE-IN
N.O.
6" HWH
EXISTING 6" HWH
Condensate Return to
Wood Boiler Plant
T2
PRV
T1
From Auxillary
Boiler Room
PI
M
LS
1 1/2" P.C.
FQI
CONDENSATE
RECEIVER

FIGURE 6.2/1 GNWT HEADQUARTERS BUILDING
CENTRAL WOOD BOILER PLANT TIE-IN

Pinecrest Hotel

The tie-in method to deliver steam energy to the Pinecrest Hotel boilers is identical to the concept described for the new Federal Building. A single steam-to-water heat exchanger is installed in the existing common boiler return water line. A condensate receiver and pump package is installed. Steam flow controls are added to regulate steam flow in relation to heat demand.

Hudson's Bay Store

Steam to air heat transfer coils are installed in the plenums of each of the four existing furnaces. Steam is piped to each of the coils and condensate is collected in a condensate receiver tank for return to the wood boiler plant. The pumped condensate is metered to provide a measure of energy delivered for billing purposes. Separate thermostat controls are added to control steam flow to each furnace pair, and furnace fan operation in response to heat demand.

ENGINEERING SERVICES

A variety of engineering services must be completed to make this project a reality. Most of these services relate to the distribution system side of the project, since the boiler plant detailed design, supply and erection is intended to be a single package contract (already estimated). The distribution system installation would be tendered to a mechanical or general contracting firm. Accordingly, installation drawings and plans for the tie-in of steam energy at each building location must be prepared. Materials must be accurately specified, the layout, routing, and final sizing for the underground distribution line network must be drawn up. Discussions must be held with the chosen boiler system vendor to work out control, metering, and mechanical tie-in interfaces between the distribution system and the boiler plant. All of these actions may be collectively termed "preparation of a system specification".

Engineering services are required to develop a distribution system construction tender package, evaluate the bid responses, select and negotiate a contractor. Upon project contracts award, engineering assistance would be prudent to supervise the construction work and the commissioning and start-up activities.

BUSINESS PLANNING

A number of tasks must be completed on the business side of this venture to bring the project to reality. These include:

- negotiation of heat energy sales contracts with clients
- negotiation for easements on property to run underground distribution lines
- arrangement for property to house the wood boiler plant
- arrangement of project capital financing and working capital financing
- hiring of plant operating personnel
- set up of wood fuel supply contracts
- set up of an incorporated business entity
- set up of business financial control system

TABLE 6.2/1

ESTIMATED CAPITAL COSTS TOWN CORE CENTRAL WOOD BOILER FACILITY AND DISTRIBUTION SYSTEM

#	Item	Cost
1.	Low pressure steam wood boiler plant consisting of: - 1 APSCO/VYNCKE LD1750/S boiler (7,000,000 BTU/hr output capacity), 15 psi steam output. - APSCO/VYNCKE SSK boiler feed auger (stoker) - APSCO wood chip storage and outfeed system including a 15' x 23' x 10' deep storage bunker with hydraulically operated live bottom, bunker outfeed auger and bunker to stoker transfer auger - APSCO Multi-300 Ash Separation Cyclone Scrubbers c/w induced draft fan and actively controlled air flow bypass damper - APSCO chimney, 26" dia., 30' tall, steel, self-supporting, uninsulated - boiler operating and safety controls, control and power distribution panel - condensate return reservoir and pump - boiler water treatment system - supply of 24' x 48' steel building with 18' sidewall, 30° pitch roof and concrete foundation and floor - supply of labour services to install and erect the above.	289,829

FIGURE 6.2/1 (continued)

#	Item	Cost
2.	Flow Line Installation Costs (partitioned as shown to assist with incremental economic analysis refer also to Figure 6.1/1)	
	a) common portion of line, from the boiler plant to any of: RCMP, NWT H/Q Bldg., Federal Bldg. or Winerack Bldg. 125' x $120/ft.	15,000
	b) portion of underground flow line common to any of a) above, except the NWT H/Q Bldg. 60' x $120/ft.	7,200
	c) portion of underground flow line common to Federal Bldg and Winerack Bldg. 50' x $120/ft.	6,000
	d) portion of underground flow line dedicated to RCMP service 290' x $120/ft.	34,800
	e) portion of underground flow line dedicated to the NWT H/Q Bldg. service 80' x $120/ft.	9,600
	f) portion of underground flow line dedicated to Federal Bldg. service 20' x $120/ft.	2,400
	g) portion of underground flow line dedicated to Winerack Bldg. service 350 ' x $120/ft.	42,000
	h) underground flow line from the boiler plant to the Pelican Rapids Inn 370' x $120/ft.	44,400
	i) common portion of underground flow line from the boiler plant to the Bay and Pinecrest Hotel 460' x $120/ft.	55,200

FIGURE 6.2/1 (continued)

#	Item	Cost
	j) portion of underground flow line dedicated to the Pinecrest Hotel service 20' x $120/ft.	2,400
	k) portion of the underground flow line dedicated to the Bay Store service 70' x $120/ft.	8,400
	Sub Total	227,400
3.	Building Tie-In Costs:	
	a) Planned New Federal Bldg.	
	- pipe, valves, related materials	6,600
	- exchanger, condensate receiver and pump, controls	6,500
	- shipping on materials	1,400
	- installation labour	6,000
	Sub Total	20,500
	b) RCMP Detachment Office	
	- pipe, valves, related materials	3,000
	- exchanger, condensate receiver and pump, controls	5,900
	- shipping on materials	1,400
	- installation labour	5,600
	Sub Total	15,900
	c) GNWT Headquarters Bldg.	
	- pipe, valves, related materials	9,200
	- exchanger, condensate receiver and pump, controls	8,500
	- shipping on materials	3,000
	- installation labour	12,000
	Sub Total	32,700

FIGURE 6.2/1 (continued)

#	Item	Cost
	d) Winerack Building	
	- pipe, valves, related materials	5,400
	- exchanger, condensate receiver and pump, controls	6,000
	- shipping on materials	1,400
	- installation labour	5,500
	Sub Total	18,300
	e) Pelican Rapids Inn	
	- pipe, valves, related materials	13,400
	- exchanger, condensate receiver and pump, controls	8,500
	- shipping on materials	3,000
	- installation labour	12,000
	Sub Total	36,900
	f) Pinecrest Hotel	
	- pipe, valves, related materials	6,600
	- exchanger, condensate receiver and pump, controls	7,600
	- shipping on materials	1,400
	- installation labour	6,000
	Sub Total	21,800
	g) Hudson Bay Store	
	- pipe, valves, related materials	16,000
	- exchanger, condensate receiver and pump, controls	9,300
	- shipping on materials	3,000
	- installation labour	15,500
	Sub Total	43,800
4.	Engineering Services	
	- specification preparation	30,000
	- tendering and contractor selection	7,000
	- project installation/commissioning supervision	20,000
5.	Business Planning	15,000
	PROJECT TOTAL CAPITAL COST	$779,129

Note: 1. Equipment prices include shipment to Fort Smith and reflect current prices in late 1984.

2. Package price based upon a turnkey project proposal by APSCO Engineering Ltd.

6.3 OPERATIONS AND MAINTENANCE COSTS

The NWT Boilers and Pressure Vessels Ordinance Regulations (April 27, 1982 Amendments) define the proposed wood boiler plant to be "heating plant class" as opposed to one of the "power plant" classes since maximum steam operating pressures are less than 103.88 kPa (15 psig). As such, the plant must be operated by a holder of a Building Operator B Certificate of Proficiency or higher certification. (Note: if the maximum working pressure exceeds 103.88 kPa, a Class 3 Engineer's Certificate of Proficiency is required).

For the purposes of this analysis, two operations and maintenance staff are included. The chief engineer would hold a Class 3 Engineer's certificate, and the second person would hold an Operator B certificate. In general, the operators would work at different times, perhaps including split shifts or periodic callouts to check on operations at regular, but unusual times during peak heating conditions. The facility would be staffed approximately on a half-time basis accordingly.

The job of the operator includes the following duties:

- monitor output pressure of the boiler in relation to demand conditions.

- monitor/verify smooth operations of chip fuel feed system.

- remove/dispose of accumulated fly ash from cyclone scrubbers (weekly)

- dismantle/clean the boiler two or three times per year

- miscellaneous servicing of pumps, motors, gauges, etc., as possible.

The estimated costs of operations and maintenance are assembled in Table 6.3/1. The costs reflect the wages and benefits of operators, administrative overheads (assumed to be available on a fee for services basis through the Fitz-Smith Native Development Corporation) and an allowance for repair tradesmen and materials.

It is expected that some operating and maintenance costs for the individual building owners will be reduced due to the tie-in to a central system. This recognition is important during the negotiation of heat sales contracts. No attempt is made here to estimate the actual oil boiler related operating and maintenance cost savings likely in each building.

TABLE 6.3/1 ANNUAL OPERATIONS AND MAINTENANCE COSTS
TOWN CORE WOOD BOILER HEATING PLANT

#			Cost
1.	Operator Wages and Benefits - two operators		$ 75,000
2.	Vehicle expenses - lease, and operating costs	ALLOW	7,000
3.	Administration Overhead	ALLOW	12,000
4.	System Repairs and Maintenance - contracted out:		
	allow 4% of plant cost		12,000
	allow 2.5% of distribution system cost		10,500
5.	Boiler Plant Utilities - electricity, sewer and water		7,800
		TOTAL	$124,300

6.4 ECONOMIC VIABILITY

The economic viability for the proposed town core central heating system is based on the premise that heat energy is sold to individual clients at a rate to just equal their current total annual fuel costs for heating with present oil fired (or electrical) heating equipment. This assumption is made in attempt to balance out the real life opposing factors that a) the building owner would expect some overall cost saving in heating costs in order to induce him to subscribe to the central system, and b) the present owner has labour and equipment maintenance and operating costs that are associated with his current heating system, which he can expect to save, due to subscription to the central steam heating system. The implied situation is therefore that the owner will be sufficiently induced to subscribe to the central systems on the strength of savings in non-fuels related operating and maintenance heating system costs.

Accordingly, the expected revenue realizable by the heating plant is equal to the sum of the current fuel costs in each client building. These costs are tabulated throughout Chapter 5 and total $150,920.00 per annum. From the same tables (5.2/2 - 5.8/2) a total of 592.7 cords of air dried wood fuel would be required to generate the energy required. Assuming an extra 5% volume in wood fuel is needed to overcome transmission line heat losses, and a wood fuel cost of $67.00 per cord, the heating plant wood fuel cost would be (592.7 x 1.05 x $67.00) $41,696.00. The non-fuel related operating and maintenance costs for the central heating plant were assembled in Table 6.3/1 and totalled $124,300. Therefore, the heating plant will sustain a total annual operating cost of ($124,300 + $41696) $165,996 in order to earn a revenue of $150,920.

CONCLUSION: A town core central heating plant, configured, and operated according to the labour and cost assumptions indicated in this chapter, will operate at a financial loss.

COMBINED PROJECTS

The foregoing simple analysis indicates that the initially conceived town core central wood boiler heating project is not viable. The major contributing factor to this result is the significant labour cost burden recognized in the Operating and Maintenance Budget. It may be possible to reduce this charge to the project by sharing the manpower resources with the "school district" central wood boiler plant project currently planned by the Fitz-Smith Native Development Corporation Ltd. Suppose that the net operating labour charged to the project is reduced to one-half man year (from two man-years allowed in Table 6.3/1) or $17,000. Further assume that vehicle and administrative costs (items 2 and 3, Table 6.3/1) can be trimmed to $9,000 per annum, from $19,000. The non-fuel related operating and maintenance cost for the facility would be reduced to $56,300 from $124,300 per annum. On this scenario the facility would sustain a total operating cost of ($56,300 plus $41,696 for wood fuel) $97,996 per annum to realize a revenue of $150,920 per year, or generate a $52,924 per annum operating funds surplus. On a simple economic payback basis, the total project capital cost of $779,129 would be recovered in ($779,129/$52,924) 14.7 years.

The discounted net present value algorithm employed throughout Chapter 5, indicates the following, on a 20 year life time basis.

1. Capital Cost: $799,129

2. Annual Net Operating Savings (Costs):

   - o Energy 150920 - 41696 = $109,224
   - o Operations & Maintenance (56,300)

   NET $ 52,924

3. Discounted Net Operating Savings:

   n = 20 years
   r = 7% per annum (∴ DF = 10,594) $560,677

4. Discounted Net Present Value: -$218,452
   (#3 - #1)

5. Effectiveness Ratio: $\frac{\#4}{\#1}$ = ________ = nil

On the basis of a "return on investment" decision rule, an investment in year 0 of $779,129 that returns $52,924 per annum for 20 years, represents an investment earning a compounded annual rate of return of approximately 3%.

CONCLUSION: The town core central heating plant configured and operated as assumed in the preceeding "combined project" scenario is not sufficiently attractive financially for the Fitz-Smith Native Development Corporation Ltd. to proceed without substantial (say 70%+) government grant financing.

SMALLER SCALE TOWN CORE PROJECT

The project viability may be improved if certain buildings are left out of the project. To test this possibility, the addition of the RCMP detachment building was considered. The capital and operating and maintenance costs schedules in sections 6.2 and 6.3 were reviewed. The deletion of the RCMP building is assumed to have a negligible affect on the boiler plant capital cost and on the cost of the "common portion" of the underground distribution line (serving also the GNWT Headquarters Building, the federal building, etc.). The capital cost savings of $34,800 for distribution flow line (item 2(d), Table 6.2/1), $15,900 for building tie-in (item 3(b)), and perhaps 5,000 in engineering services are possible. The raw capital cost for this project is reduced from $779,129 to be $723,429.

Project operations and maintenance costs and revenues are affected slightly since 33 cords less wood fuel is required, $8,233 less revenue is expected, and the allowance for system repairs expense is reduced (item 4, Table 6.3/1) by $1,392.00. Assuming no other operating and maintenance costs are affected, and the "combined project" scenario as described above applies, the net annual project savings of $52,924 is reduced to ($52924-8233+33x$67+$1392) $48,294 per annum. The simple economic payback period on this project is (723429/52924) 13.7 years (as opposed to 14.7 years with the RCMP building included).

The next least profitable building to service is the Pelican Rapids Inn. If both the RCMP building and the Inn were deleted from the project, the cost estimates change as follows. The project capital cost can be reduced to ($779129-34800-15900-44400-36900-10000(engineering)) $637,129. The net operating and maintenance costs savings per year would change from $52,924 per annum to ($52924-8233+33cordsx$67-$18466+75cordsx$67+3300(line repair allowance)) $36,761. The simple economic payback period for this project is (637,129/36,761) 17.3 years.

This result is somewhat conservative since capital costs may be reduced to below $637,129 since the boiler plant can be down sized slightly due to the reduction in required capacity. This cost saving is not reflected in the 17.3 years payback computation, but is unlikely to be large enough to reduce the payback to even 16 years.

Other building deletions were contemplated in the analysis, but no improvements in project payback period (to less than 13.7 years) were realized.

CONCLUSION: A town core central wood boiler heating project is slightly more viable with the deletion of the RCMP building from the project. No other building deletions are economically justifiable. The project without the RCMP Building, still does not have sufficient viability to attract equity investment of the full capital project amount by the Fitz-Smith Native Development Corporation.

7.0 CONCLUSIONS AND RECOMMENDATIONS

The salient conclusions from this assignment are summarized in the following paragraphs. Substantiation for these conclusions can be found in the relevant sections throughout the report.

Recommendations arising from the work are similarly summarized in this section.

CONCLUSIONS

Chapter 1.0

Not applicable.

Chapter 2.0 Building Convertability

a) All buildings considered here can be simply modified, or are currently able to accommodate the addition of a dedicated wood fuelled hot water boiler, except for the Winerack Building. The main floor and lower floor (but not the upper floor) of the Winerack Building can be heated by a wood fuelled boiler.

b) All buildings considered can be simply modified or are able to accommodate the supply of low pressure steam heat energy, generated from a remotely located wood fired boiler plant (except as noted above for the Winerack Building).

Chapter 3.0 Owner Interest

a) In aggregate, building owner attitudes were neutral toward the installation of individual wood heating units to heat their building.

b) Owners are obviously motivated to adopt measures to reduce heating costs.

c) Building operators (as distinct from the Owners) have attitudes ranging from negative to "luke warm" toward the operation of wood fired boiler equipment.

d) Centrally located multi-customer heating plants are preferred since operating and maintenance issues remain the responsibility of the central plant operator.

e) Private building owners are interested in wood heating technology, are anxious to save money, but do not have large investment funds available.

f) Government owners are prepared to adopt wood heating technology, but primarily at the initiative of a private entrepreneur.

g) The negative attitudes found in some building operations and maintenance staff can probably be overcome through education on the capabilities and modern features of current wood burning systems.

h) Owners generally prefer to retain their existing oil fired heating equipment, as "insurance", for stand-by service to back up a wood heating plant.

Chapter 4.0 Heating Equipment

a) Technically appropriate wood fired boiler units, and wood chip feed systems are available for the heating applications encountered.

Chapter 5.0 Individual Boiler Systems

a) A wood boiler plant, optimized and sized to provide dedicated service to an individual building has the following economic viability, as implied by the simple economic payback period approach: (ie. years of operating savings required to repay the initial capital cost)

Federal Building	7.1 years
R.C.M.P. Detachment Office	21.0 years
GNWT Regional Headquarters Building	7.0 years
Winerack Building	9.6 years
Pelican Rapids Inn	9.8 years
Pinecrest Hotel	2.8 years
Hudson's Bay Store	23.6 years
MOT Maintenance Garage	14.5 years
MOT Terminal Building	28.9 years
MOT Flight Service Centre and Terminal (combined)	24.4 years
Flight Service Centre Only	----

b) A single wood boiler heating plant, serving the three MOT buildings examined, is economically inferior to a facility dedicated to the maintenance garage only.

Chapter 6.0

a) A technically suitable town core central wood boiler heating system can be conceived with commercially available equipment.

b) A town core central wood boiler heating system involving the seven buildings noted elsewhere cannot be operated to earn a profit on operations, without increasing the heating costs to the clients above their current levels, or without sharing operating and maintenance expenses with another major wood boiler project.

c) Operator labour costs are the major operating and maintenance expense for a wood boiler plant operation, and in this case, the costs of the jobs created represent an explicit incremental cost to the wood boiler alternative when comparing it to the current situation.

d) The significant cost sharing of labour services (and hence costs) with another major wood boiler heating project can result in this project generating a profit on operations. The level of profit is not likely sufficient to attract equity investment, however.

e) Minor improvements in project viability are possible with the reduction in scope of the project (delete the smallest and furthest away buildings), but viability is not sufficiently improved to warrant private sector equity investment.

RECOMMENDATIONS AND SUGGESTIONS

a) Concerning the Town Core Central Wood Boiler Plant

The Fitz-Smith Native Development Corporation Ltd. should present the findings of this assessment to various agencies who may offer non-repayable grant funds for this project. If preliminary indications suggest that $400,000 - $500,000 in such funds can be secured, formal applications for funds should be made. If the funds are not likely available, discontinue further interest in the project.

b) Individual Building Wood Boiler Facilities and the MOT Buildings Applications

The F/S NDC should approach a reputable wood boiler systems supplier, with equipment suitable for the applications assessed, and negotiate a joint venture business relationship. The contributions of the partners of the joint venture are:

Equipment Vendor

- supply boiler and related equipment manufacture
- provide installation supervision
- provide project financing as required
- assume lead role in marketing of the systems to the Fort Smith clientele

Fitz-Smith Native Development Corporation

- supply results of this assessment
- supply sales contacts to purchase wood boiler equipment in the buildings addressed herein
- support sales discussions and negotitations
- supply system installation, contracting and labour services
- offer long term wood fuel supply contracts

Together, the joint venture could approach the individual building owners with reasonably viable opportunities to negotiate their purchase of wood fired heating equipment for dedicated service to their buildings.

8.0 IMPLEMENTATION PLAN

The following brief implementation guideline is provided to elaborate on the recommendations made in Chapter 7.0.

CENTRAL WOOD BOILER PROJECT

The town core central wood boiler project, even in its modified form with a reduced number of buildings, and shared operating labour with another project, does not generate sufficient revenue to provide an adequate return on investment for equity funds invested by a private corporation. The project does have other benefits not directly measured in financial terms, such as the creation of jobs in the woodlot and at the plant, a reduction in the outflow of funds from the NWT to pay for fuel, and the demonstration of a technology with promise for replication in other MacKenzie Valley communities.

These more intangible benefits may attract investment from government agencies in the form of non-repayable grants. If the investment required by the Fitz-Smith Native Development Corporation Ltd. (F/S NDC) can be significantly reduced, and the revenue from the project accrues to the F/S NDC, then the net investment may earn a sufficient return to induce the Corporation to pursue the investment.

1. The President of the F/S NDC should approach a number of potential grant funding agencies, such as: The Remote Community Demonstration Program - EMR Canada, Special - ARDA - Regional Industrial Expansion Canada, Native Economic Development Program - Regional Industrial Expansion Canada, the EDA-GNWT, Economic Development Programs of DIAND, Manpower Development Programs of CEIC, etc..

   Each agency should be briefed on the project, the project costs, and benefits. Criteria for the approval of grants should be determined together with their willingness to contribute to the project. If there are reasonably solid indications that $450,000 or more of the $779,129 can be raised through grants, then the remaining $329,000 invested by the F/S NDC is estimated to earn $52,924 per annum, or approximately a 15% return on net investment. If grant funds to this level cannot be raised, drop further consideration of the town core central heating project.

2. If appropriate grant funds are accessible, initiate formal applications for these funds.

3. Negotiate with the various building owners for the purchase of steam energy.

4. Arrange for investment of the F/S NDC portion of the capital through assignment of existing financial resources and/or through debt financing.

5. Negotiate for the assignment of property to locate the boiler plant and for easements for the burial of underground flow lines.

6. Engage an engineering consultant to thoroughly specify the required system, arrange for tenders, etc., as outlined in "Engineering Services" in Chapter 6.2.

Failure to successfully complete any of the above steps will cause the project to stop.

INDIVIDUAL BUILDINGS WOOD BOILER UNITS

If the town core wood boiler project does not proceed, there is still some opportunity for the F/S NDC to benefit from this assessment. Appropriately sized and located wood boiler heating systems are economically attractive to certain individual buildings, as noted in Chapter 5.0. While it is probably inappropriate for the F/S NDC to purchase and install these units for dedicated service to a single client, the F/S NDC could provide contract installation services and long term wood chip fuel supply services to building owner purchased wood boiler units. (The buildings referred to here are those listed at the start of Chapter 7.0, and specifically include the wood boiler heating opportunities for MOT at the Fort Smith airport.)

1. The President of the F/S NDC should approach each of the building owners and present the economic and technical details of this assessment as it pertains to their building. Their willingness to invest in the purchase of a dedicated wood boiler plant should be firmly established.

2. The F/S NDC should identify suitable candidate partners, and negotiate a joint venture with a boiler systems vendor to supply and install dedicated wood boiler systems to the buildings where purchase intentions were indicated in Step 1, above.

3. Firm proposals should be submitted to the interested purchasers and system supply contracts negotiated.

REFERENCES

1. EMR. Canada "Federal Internal Energy Program - Off Oil Programs Implementation Manual." Energy Mines and Resources Canada, Ottawa, 1981.

2. Manecon Limited "Feasibility Study for a Central Wood Boiler Facility, Fort Smith, NWT." Energy Conservation Division, Department of Public Works, Government of NWT, Yellowknife, NWT, 1982.

3. Manecon Limited "Opportunities for Energy Conservation Fort Smith Water Supply System" Town of Fort Smith, NWT, 1983.

4. Manecon Partnership "Fort Smith School District Wood Boiler Facility General Design and Economic Analysis" Fitz-Smith Native Development Corporation Ltd., Fort Smith, NWT, 1985.

PART 2
SCHOOL DISTRICT WOOD BOILER FACILITY

1.0 INTRODUCTION

This document reports on work to develop a general design and cost estimate for the construction and operation of a central wood fired heating system to serve the space heating needs of selected school buildings in Fort Smith, NWT. The buildings include the J.B. Tyrrell Elementary School, P.W. Kaeser High School and adjacent Mt. Avens Women's Residence, and Breynat Hall Men's Residence. The intention is for a private firm, the Fitz-Smith Native Development Corporation Ltd. to construct the facility and to sell heat energy to the Government of the NWT, the owners/operators of the buildings. The current oil fired heating boilers in each building are supervised/maintained by the operators employed by the GNWT Department of Public Works.

The concept to supply wood fired heat energy to these buildings was first raised in 1982 (references 3 & 4). The initial studies addressed a diversity of issues ranging from wood fuel availability to community acceptance to technical and economic feasibility. These studies indicated that:

- suitable technology existed for a central wood fuelled heating system.
- a very large supply of fuel wood was available.
- the existing building systems could be simply modified to accept externally supplied steam heat energy.
- community receptivity existed
- the concept was economically attractive.

The work reported here represents an update to the project concept, in which the technical concepts are refined with construction and specific hardware in mind. The economic viability of the venture is re-examined with the benefit of a detailed technical definition of the facility required to meet the heating need. The underlying purpose of the work is to convince the facilities' client, DPW, that the concept is technical sound, based on conventional or proven technology, has been thoroughly planned, and is economically viable for the owner. The work also serves to provide confidence to the owner of business viability, and confidence to other supporting agencies who may be involved in financing the project.

Chapter 2 of this report provides a summary technical description of the proposed heating facility. A detailed technical specification of the pipeline distribution system connecting the wood boiler plant to the client loads is enclosed as Appendix B.

The cost of wood fuel is an important determinant of overall project viability. The costs and considerations of eight different wood fuel harvesting/supply scenarios are presented in Chapter 3.

Chapter 4 is devoted to the assembly of capital costs for the proposed facility.

The operating and maintenance costs of the current heating systems and the proposed wood fired heating system are assembled and compared in Chapter 5. The expected economic viability of the project is computed, with sensitivity considerations outlined.

Conclusions and recommendations distilled from this work are assembled in Chapter 6.

An activity plan is outlined in Chapter 7 to serve as a guideline to identify and comment on the major steps remaining in the process to bring the central wood fired heating system to a reality.

2.0 BOILER FACILITY DESCRIPTION

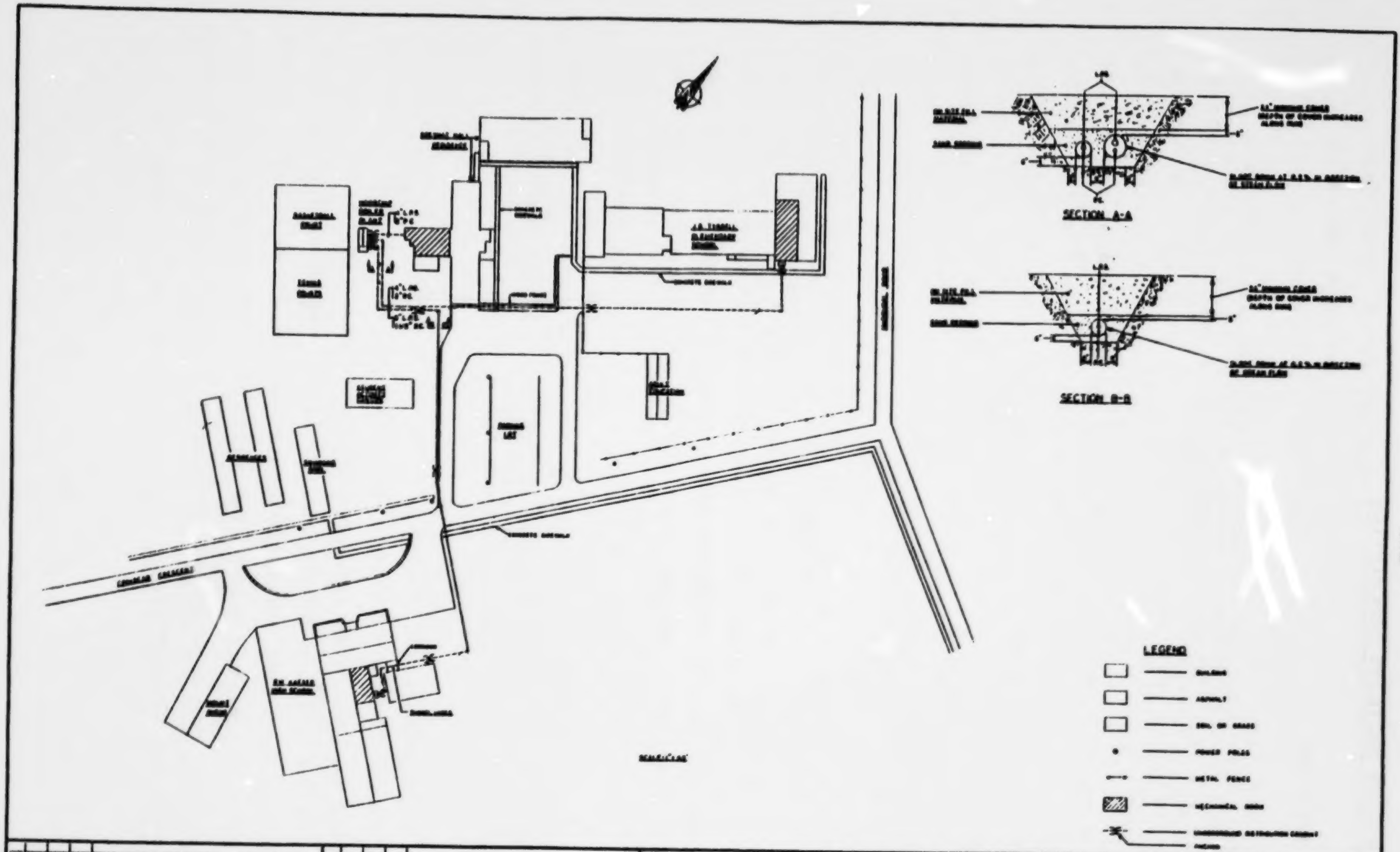
2.1 OVERVIEW

The facility that is the subject of this work consists of a single 7.0 million BTU/hr (2051 kw) wood burning low pressure steam boiler, a wood chip fuel supply bin or silo, a mechanical chip feed system to move chips from the supply bin to the boiler, a flue gas ash removal system, a building to house the boiler equipment, a distribution system to deliver steam to the heating loads, and the associated controls and plumbing to make the system operative. The steam distribution system consists of buried steam supply lines and condensate return lines, flow meters, heat exchangers, and associated plumbing, valves, traps, etc.

A site plan depicting the wood fired heating system is presented in Figure 2.1/1. The heating loads to be serviced by the facility are the two steam loads, J.B. Tyrrell Elementary School and Breynat Hall men's residence and kitchen/dining hall; and a hot water load, P.W. Kaeser High School and attached Mt. Avens Women's Residence .

Insulated, buried steam supply lines are run from the boiler plant building to the individual buildings to the tie-in to their existing building systems in each building boiler room.

The requirements for this facility, developed by the Fitz-Smith Native Development Corporation Ltd., called for a wood boiler system basically as outlined above. The boiler size, being a single 7.0 million BTU/hr unit (2051 kw) was determined with the understanding that currently operating oil fired boilers in the client buildings would be retained for back-up service. Therefore, the wood boiler configuration was not required to have operational redundancy.


SECTION A-A
SECTION B-B
CONCRETE SIDEWALK
LEGEND
POWER POLES
METAL FENCE

FORT SMITH
CENTRAL WOOD BOILER FACILITY
STEAM DISTRIBUTION SYSTEM

FIGURE 4.1/1
SITE PLAN

OCT. 84

AS SHOWN

WINKELAAR, HOWARD
& ASSOCIATES LTD.
CONSULTING ENGINEERS
CALGARY KAMLOOPS EDMONTON

M-1

The oil fired boilers to be relegated to back-up service are: two 62 boiler horse power (2,075,450 BTU/hr) Liberty low pressure steam boilers in the J.B. Tyrrell Elementary School, two 62 boiler horse power (2,075,400 BTU/hr) H.D.Smith low pressure steam boilers in Breynat Hall; and two 14.5 boiler horse power (485,000 BTU/hr) Marathon units and a 96 boiler horse power (3,214,000 BTU/hr) Cleaver Brooks Model 4 water tube hot water boiler at P.W. Kaeser High School.

2.2 BOILER PACKAGE SELECTION

A reasonably detailed boiler system design was required in order to satisfy all parties concerned that this project is technically viable, and to permit the close estimation of project costs. Two approaches were considered to develop this detailed boiler system design.

One approach is the call for proposals from boiler system vendors, in response to a description of requirements. The second approach is to engage a boiler system consulting engineer to develop a design suitable for construction by a contractor under a tendered contract arrangement. This second approach was ultimately ruled out by the Fitz-Smith Native Development Corporation, since the approach is more expensive, could result in a more expensive facility (since it fits no firms standard package design), and no suitable consultant was identified (all contacted would fall back to a boiler vendor's application engineer for guidance in any case). Since the requirement was judged to be a straight forward wood boiler application by the system vendors, and for reasons noted above, the call for proposal route was adopted. A copy of the call for proposal letter is enclosed in Appendix A.

A list of more than 20 wood boiler system vendors was initially reviewed. Ultimately, three firms were identified based upon the type of equipment offered, their installation experience, turnkey capability, and location of manufacturing and maintenance support offices. These three firms were invited to Fort Smith to meet with representatives from GNWT-DPW, the Fitz-Smith Native Development Corporation, and F/S NDC consultants. The firms were briefed on the requirements, and were questioned at length concerning their firm and equipment to be offered to satisfy this application. Proposals received from the candidate vendors were reviewed by the F/S NDC and GNWT-DPW for technical suitability, turnkey services, after sales technical support, and system price. Since the proposals were submitted in confidence, indications of the candidate vendors ranking, their proposed systems, price quotations or decision trade-offs are not recounted here. The F/S NDC simply wish to acknowledge that the technical description of the boiler facilities presented in the following sections, and the price used for financial analysis are taken from the proposal by APSCO Engineering Ltd. of Cremona, Alberta.

The distribution system portion of the total wood fired heating system was developed through the engagement of a mechanical engineering consultant, Winkelaar Howard & Associates Ltd. of Edmonton.

2.3 BOILER EQUIPMENT DESCRIPTION

The boiler equipment described in this section represents an integrated wood fired boiler facility manufactured and supplied on a turnkey contract basis by APSCO Engineering Ltd. The equipment configuration was specifically proposed by the vendor in response to this Fort Smith requirement. APSCO boiler design is taken from the Belgian wood boiler manufacturer Vyncke, on the basis of a licensing agreement between the two firms. Specification data sheets on the equipment proposed are enclosed.

Boiler

The boiler proposed is a 7.0 million BTU/hr (2051 kw) output capacity low pressure steam boiler. The maximum supply pressure rating for the vertically oriented fire tube unit is 15 psig (206 kPa). The boiler has a 3-pass heat exchange arrangement with a refractory lined fire box. The wood chip fuel is fed into the boiler by screw augers or a stoker and forms a pile in the fire box.

Wood Fuel Feed System

The feed system consists of four major elements: a wood chip supply bunker; a bunker outfeed screw auger; a transfer auger; and a stoker or boiler feed auger. The supply bunker is a concrete walled underground space, 16' x 24' (4.9m x 7.3m) in area, and 10' (3 m) deep, located adjacent to the boiler building. The design is to permit a wood chip delivery truck to drive across the top of the bunker and to dump the whole load of chips into the bunker. A hydraulically operated, weather-proof dump hatch is fitted to the top of the bunker. The bunker side walls and roof are fitted with 2" of styrofoam insulation. The bunker is equipped with a double 1" piping coil around the perimeter for heating purposes. It is intended to keep the bunker just above freezing temperature to prevent chip-ice block formation. The heating fluid will be water/glycol heated in a small heat exchanger by steam from the wood boiler.

The bunker outfeed auger assembly will consist of a fluted 6" diameter screw auger running in a steel casing set into the bunker floor. Wood chips pushed over the auger, open on the top throughout its length, are carried out of the bunker. Chips are moved toward the outfeed auger by means of a live bottom. The live bottom consists of two hydraulically driven steel frames fitted with "shoes", i.e., steel cross-members that are wedge shaped in cross-section. Chips are pushed along the floor toward the outfeed auger by the travel of the steel frame toward the auger, but ride up on the wedge and are not carried away from the auger by the reverse travel of the frame.

The chip transfer auger is a screw auger in a steel casing that conveys chips from the bunker outfeed auger outlet to the boiler fuel feeder or stoker.

The stoker is a short length screw auger with its delivery end in the center of the boiler fire box. The stoker incorporates a rotary air lock or star valve device which can pass wood chips (like a department store revolving door) but minimizes air entrainment through the stoker into the boiler fire box. The stoker is also equipped with a water sprinkler nozzle and a safety temperature control that activates the nozzle to spray water onto the wood chips in the stoker, if wood fuel burn back into the stoker is detected.

Ash Removal System

Particulate material carried in the hot combustion gases through the boiler is removed from the gases prior to entry to the chimney and release to the atmosphere. This is performed by a cyclone action ash removal system placed in line between the boiler induced draft fan and the chimney. Flue gas is directed to one of four separate conical shaped plenums. The placement of the entry end in each plenum causes the gas to swirl in a vortex fashion. Particulate is forced centrifugally to the side walls and falls into a collection can at the bottom of the separator unit. Cleaned air is exhausted through the top center of the cone to the chimney. The system proposed is rated to reduce ash emissions to less than 300 milligrams per cubic metre of exhaust gas.

Controls

The wood boiler system would be equipped with the following operating and safety controls, and indicators.

- steam pressure control
- maximum steam pressure safety control
- low water level control
- condensate tank pump control
- flue gas low temperature control (fire extinguished monitor)
- flue gas high temperature limit control
- furnace internal pressure gauge
- furnace internal pressure control with a servometer and a modulating draft damper
- stoker fuel burn back control
- minimum firing rate timer and control.

Control logic and switch gear are located in a cabinet to be mounted in the boiler room. An alarm and status panel are fitted with lamps to provide status indication of operating condition.

Miscellaneous Equipment

The facility is also equipped with the following items:

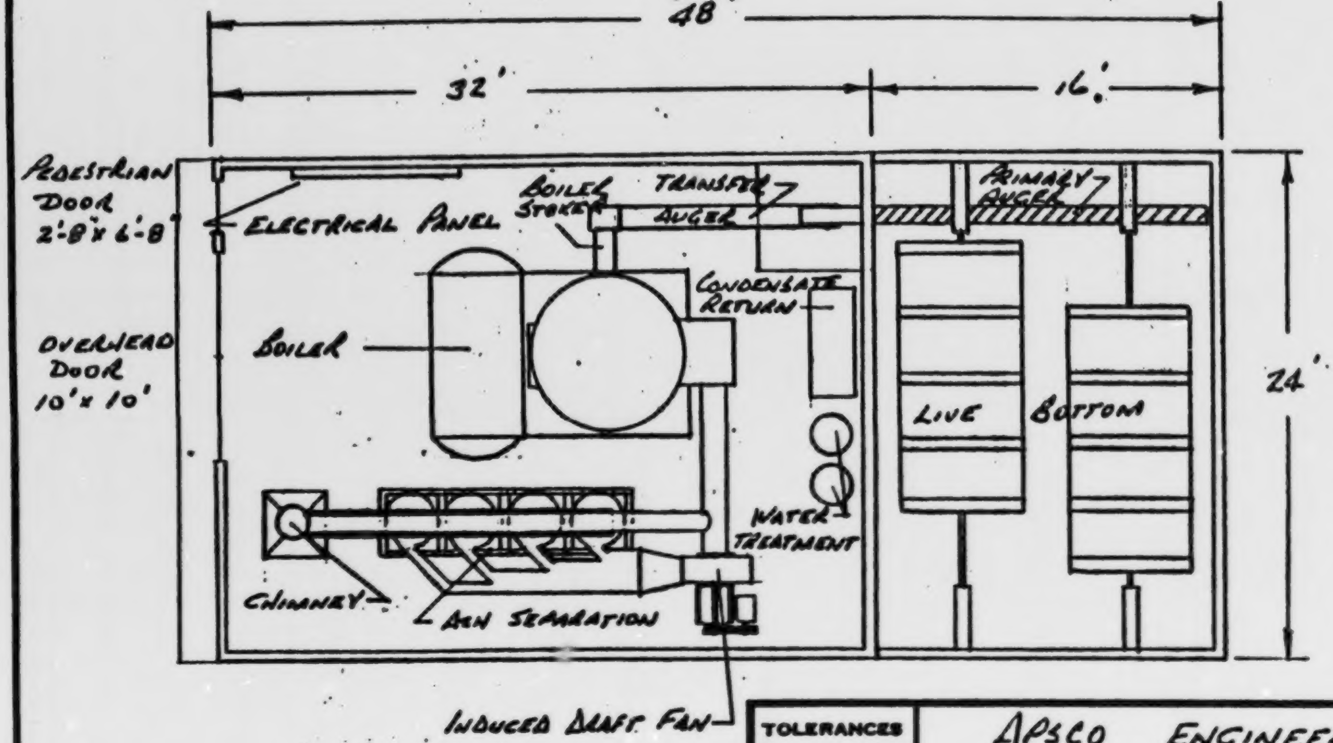
- a 26" (66 cm) diameter, 30' (9.1 m) tall self-supporting uninsulated steel chimney.
- condensate receiver tank, pump and associated piping
- steam drum and associated piping
- make-up water treatment reservoir, pump, and automatic metering of chemicals.

Boiler Plant Building

The boiler will be housed in an R-12 fiberglas insulated metal building (steel "I" beam frame and metal clad exterior). The structure's profile will be 32' x 24' (9.75m x 7.3 m) in plan dimensions, a 30° pitch roof and 18' (5.5 m) sidewalls. The exterior will be painted a light brown or sandstone colour to compliment surrounding buildings. A 10' x 10' (3 m x 3 m) overhead door and a regular pedestrian door will provide building access.

The building will be constructed on a concrete foundation and have a concrete floor (sloped to a sewer drain). Electrical service to the facility is specified to be 460 volt, 200 amp with an operating peak demand of 50 amps expected.

DATE	SYM	REVISION RECORD	AUTH.


48'
32'
16'
24'
PEDESTRIAN DOOR 2'-8" x 6'-8"
OVERHEAD DOOR 10' x 10'
ELECTRICAL PANEL
BOILER STOKER
TRANSFER AUGER
PRIMARY AUGER
BOILER
CONDENSATE RETURN
LIVE BOTTOM
WATER TREATMENT
CHIMNEY
ASH SEPARATION
INDUCED DRAFT FAN

TOLERANCES (EXCEPT AS NOTED)	APSCO ENGINEERING LTD. CALGARY ALBERTA		
DECIMAL ±	LD-1750S BOILER	SCALE 1/8"	DRAWN BY JPD APPROVED BY
FRACTIONAL ±	TITLE FITZ-SMITH NATIVE DEVELOPMENT CORP. LTD PROPOSED WOOD-CHIP BOILER		
ANGULAR ±	DATE AUG /84	DRAWING NUMBER PC-84050-1	

K•F CRYSTALENE ® 10 5466

MADE IN U.S.A.

VIF

SPECIAL BOILER FOR COMBUSTION OF SOLID FUELS AND WASTE

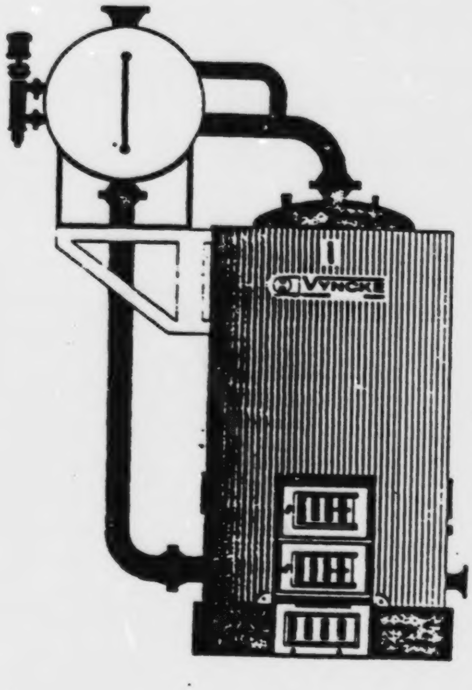
Medium : low pressure steam, hot water
Output : 1 250 000 - 3 000 000 kcal/h
1 450 - 3 500 kW

RANGE LD 1 250 - 3 000

ENERGY FROM ...

Wood, paper, cardboard, packing materials, fabrics, bark, coal, agro-waste (bagasse, palmfruit- and coconutwaste, soja ...) ...

Vertical three draught boiler, with a very spacious furnace built, as it were, around the flame, with a separate steamdrum connected with the boiler by means of circulation pipes.



Characteristics :

1. MAXIMUM HEAT TRANSFER

Due mainly to the radiation in the vertical furnace, in which the flame burns completely without coming into contact with the 'cold' wall of the boiler.

Thanks to the sensibly chosen velocity of the flue gases in the vertical convection part, fly ash is removed.

Also, due to the result of good insulation of 50 mm rockwool, covered by lacquered steel plate.

2. OPTIMUM COMBUSTION

As a result of the separate regulation of primary and secondary air and thorough mixing of the air, with the fuel and combustion gases.

Also, due to the induced draught fan which keeps the under pressure constant, even with varying quantity of fuel. Controlled manually or automatically by means of the flue gas valve.

As a result of the fire - proof lining which is sufficient and yet as limited as possible thereby allowing the combustion temperature to maintain the required level.

3. LONG LIFE

Solid construction - made of quality steel boiler plate in accordance with DIN / NBN / ASME / BS / ... standards.

Hydraulic test to 1,5 times the maximum working pressure.

The watercooled reversing chamber avoids a fragile refractory lining.

The optimum watercirculation results in an even dilatation of the material.

4. GREAT ACCESSIBILITY FOR CONTROL AND MAINTENANCE

The large double filling door allows access to the furnace and the grate.

The reversing chambers are accessible via an adapted socle and via removable inspection covers above and beneath.

5. SAFE AND SIMPLE CONTROL

The furnace being subject to a negative pressure prevents back-fire.

The regulating and safety pressure switches determine respectively the desired and the maximum steampressure. The safety relief valves protect against too high pressure.

A float switch checks the water level. Visual control is done with a sight glass and an electrode is fitted as an additional safety device.

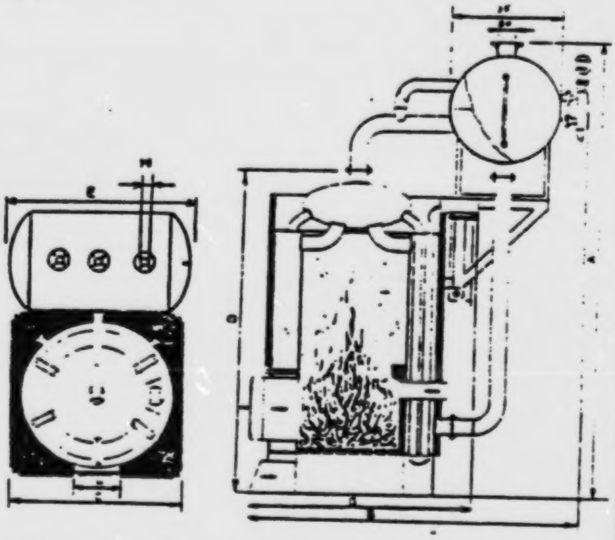
6. FULLY ADAPTABLE FOR USE WITH THE "VIMATIC" STOKING SYSTEMS FOR ALL KINDS OF SOLID WASTE AND FUELS

- SSK : screw stoking system
- PSS : tangential blow-insystem
- VVH : underground pre-furnace with stepped grate
- RWR : pneumatic pre-drying stoking system
- DRS : rotary grate
- KSK : stoking system with screw for coal
- DTB : dosing feed belt
- DHC : hydraulic compacting stoking system
- DSX : pre-drying system with feed belt
- WBS : fluid bed stoking system
- light fuel oil or natural gas burner

E LD BOILER INCLUDES :

insulated pressure vessel
insulated steam drum
risertubes and downcomers between pressure vessel and steamdrum
furnace with flat refractory grate
2 section manual charging doors
adjustable secondary air intake
ashdoor with primary air intake
cleaning doors on upper and lower reversing chamber
flue gas damper
provisions on the pressure vessel for the connection of feedwater-line, hotwater return, blow-off line, underpressure gange, flue gas ducting.
provisions on the steamdrum for the connection of steamsupply, hot watersupply, safety relief valves, pressure switches, steam-pressure gauge, sight glass, water level regulator and electrode.
1 steam supply gate valve
2 hot water valves (supply and return gate)
1 boiler blow-off valve
1, 2 or 3 safety relief valves
1 sight glass
1 sight glass
1 pressure gauge with check-flange
2 temperature gauges (for mounting on hot water supply and return lines)
automatic feedwater regulation :
  - water level regulation
  - magnetic valve
  - filter, non-return and gate valve
cleaning tools

magnetic valve can only be used when pressurised water is available. When this is not the case, a feedwaterpump should be installed.



This enumeration concerns the VIF-standard arrangement, which is adapted for manual feeding. The special boiler characteristics for automatic feeding are described together with the related stoking systems.

TECHNICAL DATA							
VIF MODEL LD		1 250	1 500	1 750	2 000	2 500	3 000
NOMINAL OUTPUT *	Gcal/h kW	1,25 1 450	1,50 1 740	1,75 2 040	2,00 2 330	2,50 2 910	3,00 3 490
DIMENSIONS (mm)	A B C D E ØF G	5 200 3 300 2 070 3 800 2 500 1 100 2 550	5 500 3 600 2 250 3 950 2 600 1 300 2 750	5 600 3 800 2 450 3 950 3 100 1 300 2 980	5 900 3 950 2 450 4 250 3 100 1 300 3 000	6 200 4 350 2 750 4 400 3 200 1 500 3 350	6 300 4 550 2 950 4 500 3 200 1 500 3 650
FIRE DOORS (mm)	H I	580 750	580 750	700 900	700 900	700 900	700 900
GAS OUTLET (mm)	ØJ	380	400	430	450	500	550
STEAM SUPPLY NOMINAL PIPE SIZE (mm)	ØK	150	150	200	200	250	250
FEEDWATER NOMINAL PIPE SIZE (mm)	ØL	25	25	25	32	32	32
WATER SUPPLY AND RETURN NOMINAL PIPE SIZE	ØM	125	150	200	200	200	250
BLOW-OFF NOMINAL PIPE SIZE	ØN	50	50	50	50	50	50
MINIMUM HEIGHT BOILERHOUSE (mm)		6 200	6 500	6 600	6 900	7 200	7 300
BOILERWEIGHT DRY (kg)		8 000	9 000	12 000	13 000	17 000	20 000
WATER CAPACITY (l)		4 000	5 600	7 000	7 600	9 000	10 500
MAXIMUM FUEL BURNED	Wood at Hu = 3 773 kcal/kg = 15 796 kJ/kg η = 75 % (kg/h)	442	530	618	707	883	1 060
	Light fuel at Hu = 10 031 cal/kg = 41 997 kJ/kg η = 85 % (l/h)	166	200	233	266	333	400

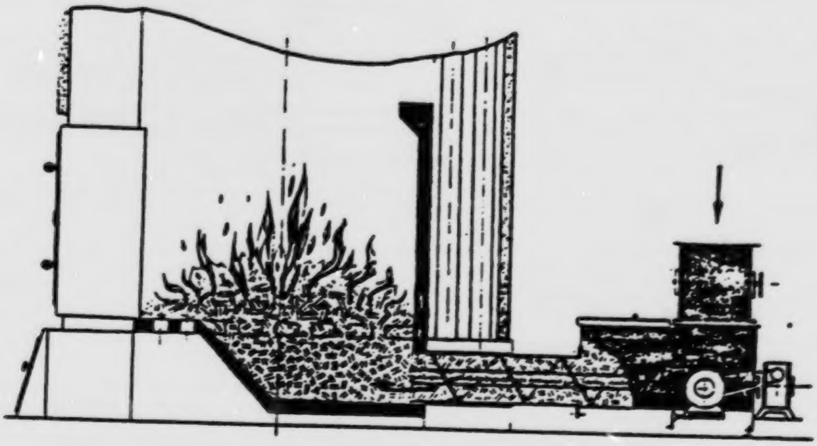
* The nominal output is calculated for fuels with a minimum heating value (Hu) of 3 773 kcal/kg (e.g. wood with max. m.c. of 16 % on bone dry basis)

MAXIMUM STEAMPRESSURE

GERMAN AND AMERICAN STANDARDS (ASME) : 1 bar
OTHER STANDARDS · 0,5 bar

VIMATIC
ssk

FOR GRANULAR WASTE
AUTOMATIC FEEDING SYSTEM



Vimatic SSK has been designed to automatically feed granular custible employing the underfeed stoking principle.

SSK can burn many types of biomass fuels with characteristics as ows :

- Maximum size of particle should not exceed 10 x 15 x 20 mm
- Maximum moisture content 50 % measured on the bone dry basis.
- Maximum Ash Content 0,5 %

1. PRINCIPLE OF COMBUSTION :

The SSK receives the biomass fuel from the metering system. The SSK by means of an Archimedian Screw feeds the biomass fuel into a U-shaped trough at the bottom of the boiler. This trough is lined with refractory concrete and forms the bottom of the boiler furnace. Primary air holes are located around this trough which supply the necessary oxygen for the proper combustion of the fuel. Because of the construction and the underfeed principle only the top layer of the fuel is consumed. As the fuel is slowly pushed upward, it is gradually heated. Near the surface of the fuel bed, the temperature rises to the point where gassification occurs. This gas is mixed with the air above the fuel bed and ignites because of the high temperature. Finally the carbonized fuel itself also comes into contact with oxygen at the surface and will be consumed. The addition of secondary air inlets above the fuel bed insures proper combustion.

2. ADVANTAGES OF THE UNDERFEED STOKING SYSTEM

Uniform Combustion :

Since the fuel is supplied from beneath the flame, very few unburned particles are carried along with the flue gas stream.

Quality combustion :

Because of the gradual heating of the fuel, the moisture content, the size of the fuel, and the density of the fuel do not greatly influence the quality of the combustion.

Independent Control of the Fuel to Air Ratio :

It is extremely important that the amount of primary air, secondary air and fuel can be controlled independently. Without this proper mix, proper combustion is impossible. With the underfeed stoking principle, primary air, secondary air and fuel can all be controlled seperately.

Automatic Reignition Without Auxilary Fuel :

The underfeed stoking principle makes reignition without auxilary fuel possible even after a relatively long shutdown period. During long periods of boiler shut down, the fuel bed will insulate itself with a very thin layer of ash. This keeps the fuel bed warm enough for automatic reignition by simple supplying a very small quantity of fuel which breaks open the fuel bed.

A hold fire timer can be provided in the control panel for automatic reignition after a very long shut-down period. (e.g. week-ends). There should remain a very small energy demand.

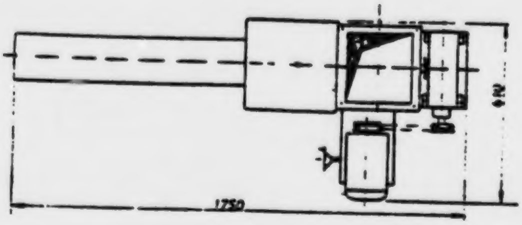
3. SPECIAL CHARACTERISTICS

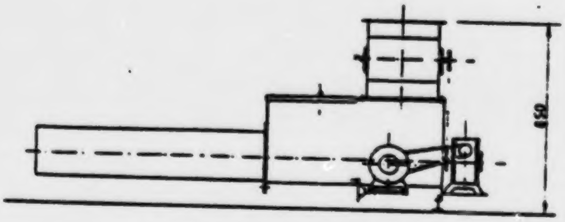
The Vimatic SSK has been designed to withstand severe working conditions.

The first section of the screw is made of high temperature steel in order to resist the radiant heat from the combustion chamber.

The screw is isolated from the metering system by means of a air tight rotary valve which protects against fire blow back.

The screw runs in two ball bearings for smooth operation. The tube in which the screw operates is protected by dual thermostatic sensors which protects against high temperature situation.





THE VIMATIC SSK INCLUDES

- refractory grate with feed trough
- underfeed stoker :
  - archimedian screw with section made of high temperature steel
  - screw tube
  - external roller bearing and internal friction bearing
  - rotary valve
  - E-motor with : gear reducer
    beltransmission between motor and screw
    chaintransmission between motor and rotary valve
- thermostatic protection :
  - dual spray line
  - pressurised water tank with valve, no-return valve, pressure gauge
  - magnetic valve with thermostat
  - valve with capillary and thermostat

TECHNICAL DATA

- dimensions : see drawing
  minimal distance between boiler and boiler-housewall : 2 000 mm
- motorpower : boilersize 300 - 2 000 : 1,5 kW
  boilersize 2 500 - 3 000 : 2,2 kW
- expeditiondata : weight : 150 kg

MULTI-300

Ash Separation System

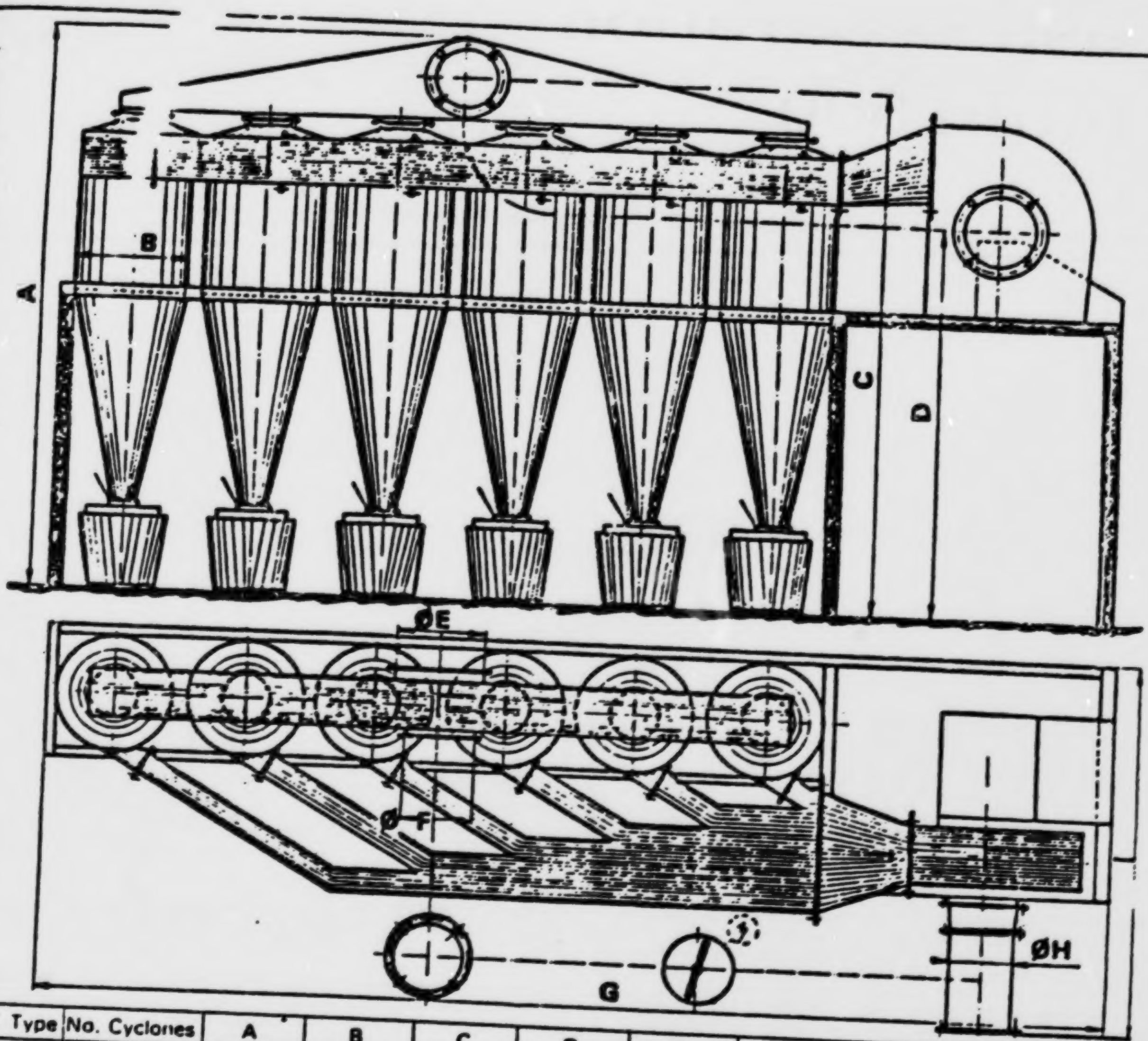
Including:

- Cyclone (s)
- Fan including motor and drive
- Ash reinjection system
- Structural support
- Ash bucket (s)
- By-pass ducting including servomotor for the Industrial Series
- Manifold ducting
- Flue gas ducting to boiler not to exceed 30'

Reference Drawing: No. V53

VYNCKE
CANADA LTD.
energy & environmental
P.O. BOX 5091 STATION A
PHONE 403 277 4204
TELEX 03-826065

DATE	REVISION	No.
12/78		VZ127



VIF Type	No. Cyclones	A	B	C	D	E	F	G	H	I
150	1	83-5/8	19-5/8	77-3/4	▨	6	6	58-1/4	6	26
250	1	95-7/8	24-7/8	90	▨	6	6	67-1/8	6	31-1.8
400	1	104-3/4	31-1/2	98-7/8	▨	8	6	73-7/8	8	37-3 4
500-550	1	150	31-1/2	141-3/4	111-1/4	11	9	79-3/4	9	59
700 750	2	154-3/8	31-1/2	141-3/4	107-1/4	14	11	117-1/2	11	78-3. 4
1000	2	157-1/2	31-1/2	141-3/4	107-1/4	17	14	117-1/2	14	70-7/8
1250	3	156-1/4	31-1/2	141-3/4	107-5/8	18	15	170 5/8	15	88-5/8
1500	3	158-1/4	31-1/2	141-3/4	107 5/8	20	16	170-5/8	16	88-5 8
1750	4	160-1/4	31-1/2	148-1/2	107-5/8	22	17	206-1/8	17	92-1/2
2000	4	160-1/4	31-1/2	148-1/2	107-5/8	23	18	206-1/8	18	92-1/2
2500	5	162 1/4	31-1/2	150-3/8	111	24	20	254	20	98-3-8
3000	6	187	31-1/2	173-1/4	118-1/8	25	22	308	22	118-1 8

All dimensions are in inches -- ± 1/8"

VYNCKE
CANADA LTD.
energy & environmental

MULTI 300
ASH SEPARATION

PO BOX [illegible] STATION A
CALGARY ALBERTA CANADA

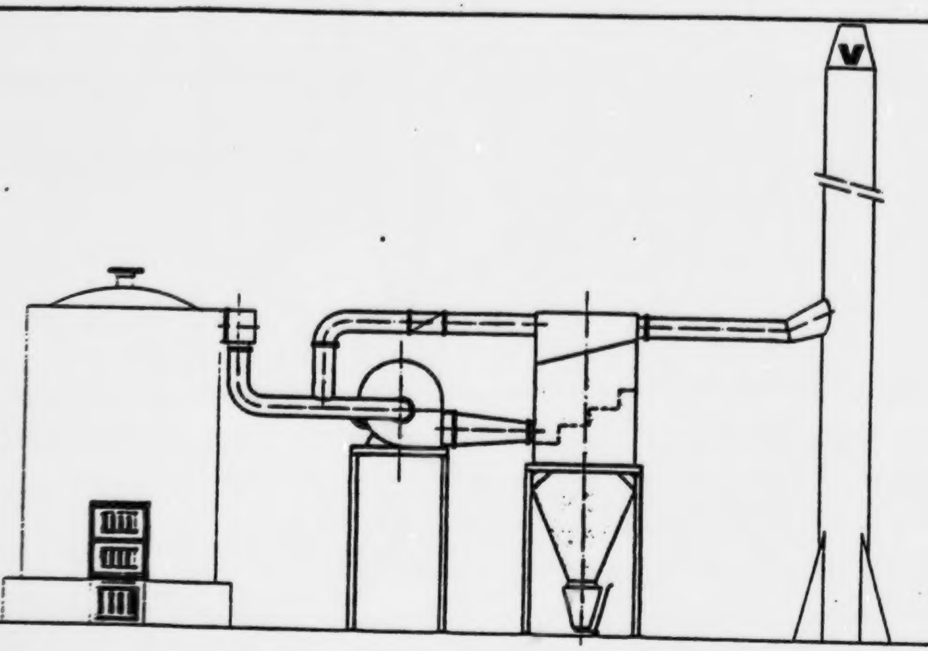
DATE 1-8-79

REVISION

PHONE [illegible]
TELEX [illegible]

No **V53**

ash separation
multi 300



CLEAN COMBUSTION :

Combustion of waste products is often associated with air pollution by flue gases, and this is partially right. As a matter of fact, the flue gases freed by the combustion of solid waste products do contain dust particles which can cause problems when they are emitted to the atmosphere. However, these particles are not necessarily harmful. Sulphuric acid, resulting from the combustion of ordinary fuel oil, for example, is more injurious than dust caused by the combustion of wood.

In several countries there exist maximum limits of emission which must not be exceeded. This can be expressed as "the weight of dust per cubic meter at standard temperature of flue gases". In many cases a limit of 300 mg per SCM is required.

In order to reach this, the following measures can be taken. With the VIF Boiler enormeous attention is given to the quality of combustion so that the emission of dust is already drastically reduced. The induced draft fan can be equipped whith a system to return the fly ash to the boiler. Moreover, a special dust seperator can be placed between the induced draft fan and the stack.

The multi 300 type ash seperator, is especially designed to meet with the above mentioned requirements, at least in the case of the combustion of biomass. It consists of a battery of cast iron cyclones, each with a diameter of 250 mm. The flue gas spreads equally to the cyclones, in which the particles of dust are hurled against the outer wall by centrifugal force. Consequently, they leave the flue gas stream and glide downwards along the wall into a collecting funnel. The purified flue gases escape upwards into a flue gas collector, from which they go to the stack.

The more strict the rules of emission, the greater the need for multiple cyclones. Each cyclone has an optimum efficiency. The greater the diameter, the lower the efficiency. Therefore, it is advisable to spread the flue gases over a number of smaller cyclones, each of which can best manage the cleaning of that part of flue gases.

The ashes fall into one or more ash can(s) underneath. Each can is attached to the collecting funnel, with an air tight seal, and can be easily removed when emptying is necessary.

Included is a conveyor cart for the carrying away af the ash cans. The can is fastened by means of a special cast iron lid, on which there is a tightening screw. In this lid there is also a valve, which can close the cyclone at the bottom. Consequently, the ash cans can be emptied without stopping the combustion system.

The fly ash return system can also be used for the return and the recombustion of the particles, separated by the Multi 300. The ash can becomes unneccessary.

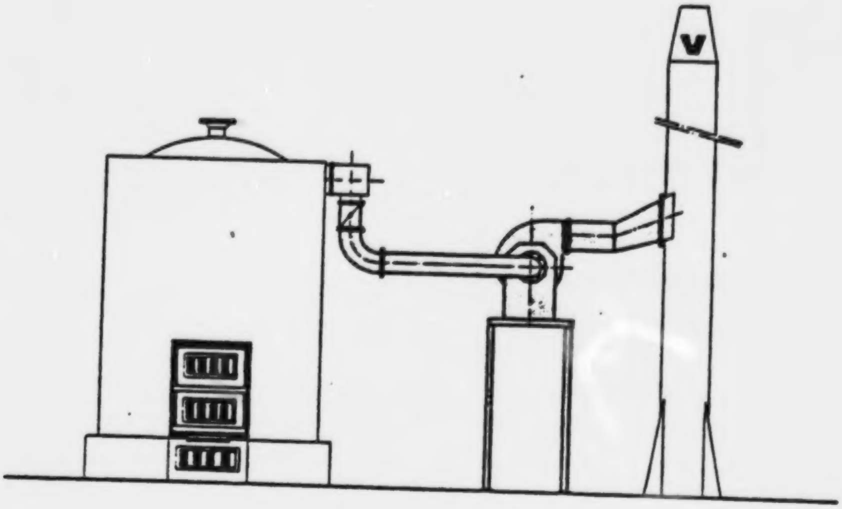
The Ash Seperator has been designed for a specific flue gas quantity. At that quantity, it has the highest degree of seperation in order to reach the above mentionned emission limit of 300 mg/SCM. Since a varying boiler loading entails a varying flue gas quantity, a by-pass pipe connects the inlet of the fan to the outlet of the ash separator.
In this pipe is a damper, which can be controlled either manually or automatically by means of a Servomotor, commanded by the negative pressure in the surface.
This damper insures that the seperator always sees the same quantity of flue gas irregardless of the boiler demand.

Remarks :

- If so required by the local legislation, an emission guarantee can be delivered.
- Fuel with a moisture content of more than 30 % on bone dry basis must be predried.

VYNCKE	Revision Replaced by	25 . 05 . 1981
LOOKING AHEAD FOR ENERGY	Due to product improvement specifications may change without notice.	VME 04.02 A

INDUCED DRAUGHT FAN REGULATION OF THE NEGATIVE PRESSURE



INDUCED DRAUGHT FAN REGULATION OF THE NEGATIVE PRESSURE

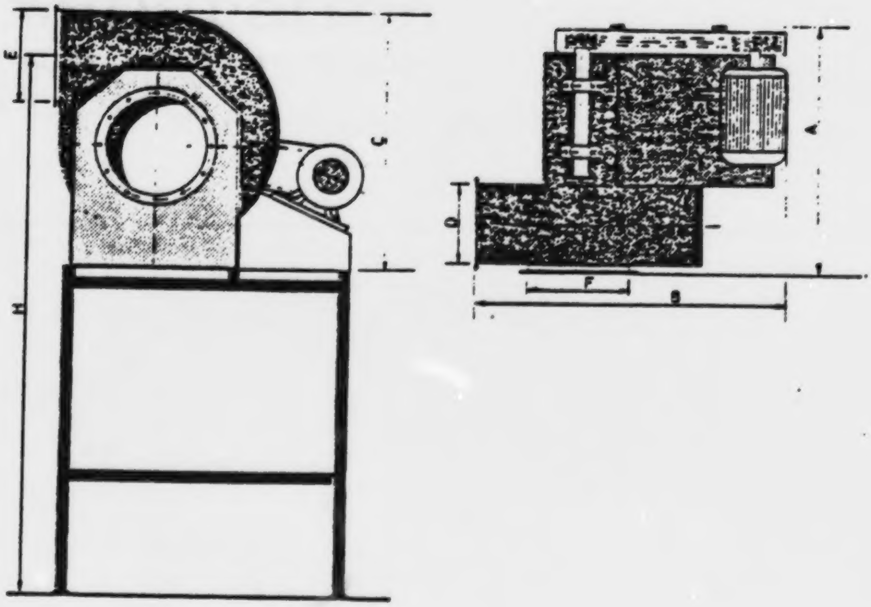
The flue gas fan draws the combustion gases out of the boiler and conveys them to the stack. This causes negative pressure in the furnace and as a result, combustion air is induced automatically. The negative pressure is directly proportional to the quantity of induced air. The more air, the more fuel can be burned per unit of time. Consequently, an increase of induced flue gases will entail an increase in the negative pressure and will increase the air flow. On the other hand, a decrease of negative pressure will mean that not enough air is being induced. Too high a negative pressure will restrict the amount of combustion gases. Therefore, in order for the flue gas fan maintain proper combustion at all loads it has to be equipped with a butterfly damper which will regulate the correct flue gas depression in relationship to the combustion required. This adjustment is done by hand or automatically by means of a Servomotor controlled by the negative pressure in the furnace.
Combustion in a negative pressure environment has a secondary advantage in that boiler blow back is prevented, which obviously increases the safety of the personnel. Therefore, it is possible to open the doors of the boiler when the boiler is normally functioning, altough in some countries this is forbidden by law.

A special fitting can be mounted in the scroll of the fan just prior to the outlet flange. This fitting is connected via a pipe to the furnace.Since the heaviest particles of the dust are centrifugally held against the scroll, they can be easily separated and blown into the furnace again where they can be burned a second time.

Before assembly the rotor is dynamically equilibrated so as to diminish vibrations.
Moreover, the transmission of vibration is prevented by means of isolation pads which are mounted between the fan and the fan frame.

The speed of the fan is kept relatively low to minimize noise.

The fan is made of high temperature resistant materials.



VIF MODEL		300	500	750	1 000	1 250	1 500	* 1 750	2 000	2 500	3 000	4 000	5 000	6 000	7 000	8 000	9 000
FAN TYPE		M 55/21	M 55/21	M 55/25	M 55/30	GT 700	GT 700	GT 700	GT 700	GT 800	GT 1 000	GT 1 000	GT 1 200	GT 1 200	GT 1 200	GT 1 400	GT 1 400
DIMENSIONS (mm)	A	618	618	776	963	1 240	1 240	1 240	1 240	1 250	1 500	1 500	1 650	1 650	1 650	2 000	2 0
	B	574	574	673	951	1 285	1 285	1 285	1 285	1 336	1 465	1 465	1 550	1 550	1 550	2 130	2 13
	C	707	707	843	970	1 325	1 325	1 325	1 325	1 505	1 882	1 882	2 200	2 200	2 200	2 420	2 42
	D	180	180	207	290	367	367	367	367	383	466	466	608	608	608	608	608
	E	210	210	250	350	455	455	455	455	500	500	650	750	750	750	850	850
	ØF	230	230	270	370	450	450	450	450	500	630	630	750	750	750	850	850
	H	depends upon the height of the boiler and/or the separator.															
MOTOKPOWER (kW) (1)		1,5	2,9	2,9	5,5	7,5	7,5	11,0	11,0	14,7	14,7	22,0	30,0	37	37	45	55
MOTORPOWER (kW) (2)		2,9	4,0	4,0	7,5	11,0	14,7	* 18,4	18,4	18,4	22,0	37,0	45	55	55	75	75
WEIGHT (kg) (1)		200	215	240	285	600	600	650	650	750	900	950	1 170	1 240	1 240	1 450	1 520
" (kg) (2)		215	220	250	395	650	670	700	700	780	950	1 090	1 280	1 350	1 350	1 670	1 670

(1) without ash separator
(2) with ash separator

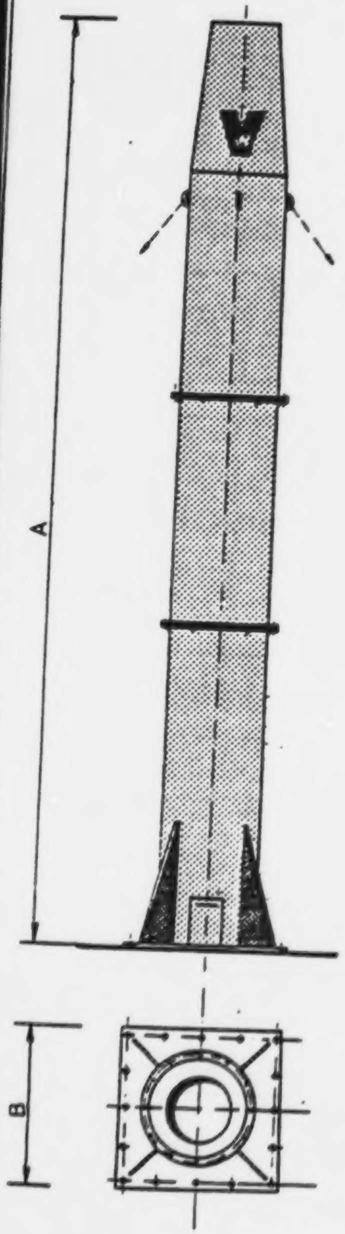
THE DELIVERY INCLUDES

- fan
- E-motor with V-belt drive
- shaft cooler
- structural steel supporting frame
- isolation pads
- breaching between boiler and fan and between fan and chimney (maximum length being about 5 meter)

OPTION : FLY -ASH REINJECTION

- fitting in the scroll with damper
- connecting pipe between fan and furnace
- reinjection pipe

STACK



STACK :

Steel stack with guy ropes for mounting after a VIF-boiler.
Standard heights 7 , 13, 19, 25 m

INCLUDING :

- mild steel stack with flanges every 6 m
- conical top
- clean-out door
- base plate
- flue gas inlet with flange
- guy ropes

OPTIONAL :

- "Carten"-steel
- insulation, covered with an aluminium jacket

SPECIFICATIONS						
BOILER MODEL VIF		300 500	750 1 500	1 750 3 000	4 000 6 000	7 000 9 000
STACKDIAMETER (mm)		13 320	18 480	26 640	36 900	44 1 100
BASE PLATE B (mm)		500	750	1 000	1 500	1 750
WEIGHT (kg)	A = 7 m	315	455	595	875	1 015
	A = 13 m	585	845	1 105	1 625	1 885
	A = 19m	855	1 235	1 615	2 375	2 755
	A = 25 m	1 125	1 625	2 125	3 125	3 625

VYNCKE LOOKING AHEAD FOR ENERGY	Revision Replaced by	25 . 05 . 1981
	Due to product improvement specifications may change without notice.	VME 06.01

CONTROLS

Prewired in a NEMA 12 Enclosure
Including:

I. REGULATION AND SAFETY CONTROLS							
DESCRIPTION		TYPE					
		Mini		Industrial			
		WW	LD	WW	LD	HD	TO
MEDIUM	Temperature Control	•		•			•
	Safety Temperature Control	•		•			•
	Pressure Control		•		•	•	
	Safety Pressure Control		•		•	•	
	Pressure Control For Protection Against Low Water Conditions	•		•			•
	Water Level Control, Two (2) Electrical, Thermostatic		•		•	•	
	Flow Control						•
COMBUSTION	Flue Gas Thermometer	•	•				
	Flue Gas Temperature Control And Safety Control			•	•	•	•
	Furnace Pressure Gauge	•	•				
	Furnace Pressure Control Through Servomotor (Modulating)			•	•	•	•
	System Purge Control	•	•	•	•	•	•
	Minimum Fire Timer and Control	•	•	•	•	•	•
II. MOTOR CONTROLS							
Magnetic Starters and Pushbuttons		•	•	•	•	•	•

2.4 DISTRIBUTION SYSTEM DESCRIPTION

The definition and specification of the steam heat distribution system accounted for the majority of work in this assignment. A full specification of the materials and construction/installation requirements are assembled into a technical specification - enclosed as Appendix B. A package of mechanical drawings supporting the specifications and the following descriptions are enclosed as Appendix C.

The distribution system was conceived around the Ricwil, Inc., Galva-Gard Prefabricated Insulated Piping System. Brochure materials are attached to this report sub-section.

Two pipes, one for low pressure steam supply, the second for condensate return, are separately insulated and enclosed in a common conduit. The conduit is 10 gauge smooth wall hot dip galvanized steel with outside surfaces machine coated with high melting point asphalt to a minimum thickness of 3/16" with an interposed layer of fiberglass reinforced pipeline felt. The individual pipe/conduit sections are field welded, with the joints field insulated and coated.

Three separate flow line pairs are specified, each leading from the boiler plant to the mechanical room of one of the building loads to be served. The three steam lines will be tied to a steam supply manifold off the wood boiler. The three condensate return lines are tied into a common condensate receiver in the boiler plant.

The lines are run underground from the boiler plant to each load, and enter the load building's mechanical rooms through their foundation walls below grade elevation.

The P.W. Kaeser line is required to cross an asphalt street, Conibear Crescent. The line is planned to run along side an asphalt parking apron at the school, under a slab-on-grade concrete floor of a corridor (connecting two portions of the school), and into the P.W. Kaeser mechanical room. The Breynat Hall line and J.B. Tyrrell lines run under grass or gravel surfaced areas only. In each case, the flow lines are laid in a sand bed in a trench that is sloped at a 0.2% grade from the boiler plant to the load building entry. This is to permit the lines to be drained in the event of extended period cold weather shutdown.

The tie-in at J.B. Tyrrell Elementary School is reasonably straight forward. The 4" diameter steam line is tied into the steam supply manifold of the existing boilers and wood boiler steam is circulated throughout the building. If the steam pressure in the manifold is maintained, the current boiler fired controls are satisfied and units will not be brought into service (but are kept on "hot" standby, warmed by the wood boiler steam supply.) Drain lines are added to the existing boilers to prevent "flooding" in this standby condition.

A condensate return pump is added to the existing condensate return reservoir package in the building, and level controls added to the reservoir to govern the new condensate pump operation (returning fluid to the wood boiler plant).

The tie-in requirements in Breynat Hall are essentially the same as for J.B. Tyrrell Elementary School.

The tie-in at P.W. Kaeser is different from the previous two, since the building distribution loops are hot water as opposed to steam. The wood boiler steam is passed through a steam to heat water heat exchanger. The condensate water is collected in a condensate reservoir package (added by this modification) and pumped back to the wood boiler plant.

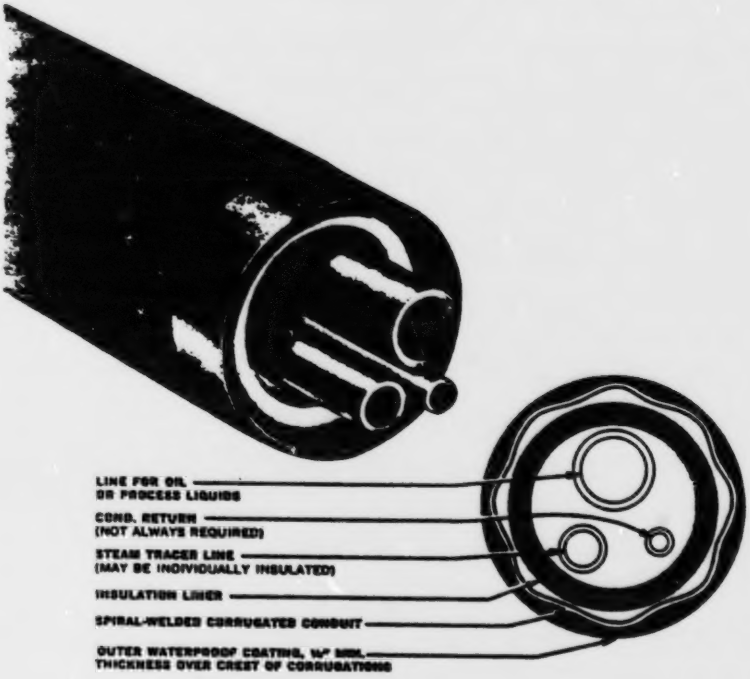
The water return line to the existing oil fired boilers is modified by this tie-in to pass through the steam/water heat exchanger to pick up heat. The hot water will pass through the oil fired boilers at a temperature to satisfy their firing controls (thus, these boilers are on hot automatic stand-by also.) The hot water will circulate through the building heating loops in the normal manner.

Flow metering is an important consideration in this installation, since energy sales transactions are involved. The approach adopted is to measure condensate return flow rates and flow totals from each load, and relate heat energy delivered to volume of condensate returned. These flow meters are installed in the condensate return lines at each load building. A master condensate flow meter is installed at the common collection point at the wood boiler plant.

As a check on the mass balance of the distribution system, (i.e. what goes in, in terms of lbs/hr of steam should show up as lbs/hr of condensate returned), a relatively expensive microprocessor based two phase flow measurement system is installed. The unit is used to measure the wood boiler steam output flow. The individual building condensate flow totals are to be adjusted against this master steam flow as the reference, in order to compensate for steam losses due to broken or leaking lines in the client buildings. Brochure materials on the ITT Barton Flow Totalizer are enclosed.

RICWIL

INSULATED NESTED PIPE UNITS...*for Oil, Other Viscous Fluids, Process Liquids*


LINE FOR OIL OR PROCESS LIQUIDS
COND. RETURN (NOT ALWAYS REQUIRED)
STEAM TRACER LINE (MAY BE INDIVIDUALLY INSULATED)
INSULATION LINER
SPIRAL-WELDED CORRUGATED CONDUIT
OUTER WATERPROOF COATING, ½" MIN. THICKNESS OVER CREST OF CORRUGATIONS

In this type of RICWIL Insulated Pipe Unit, pipes are nested inside an insulation liner so that they are insulated from the exterior but not from each other. Any desired temperature can thus be maintained in the system with tracer lines of steam, hot water, brine or any other heating or cooling medium; liquid or gas. The Uniline Insulation Liner is made of highly efficient insulating material, in any specified thickness. Individual pipes may be insulated, if required.

VISCOUS FLUIDS of many varied types require insulated piping of exacting standards and high efficiency. Oil refineries, chemical plants, asphalt manufacturers, food processors, textile and paper mills, leather goods makers and distilleries are among the many who specify RICWIL Insulated Piping Systems.

A typical application of nested type piping system is shown at left. The nested oil and steam tracer pipes are surrounded with insulation and protected by an air tested RICWIL Conduit.

ADVANTAGES OF RICWIL INSULATED PIPING SYSTEMS

- Drainable, dryable, testable
- Uniform quality, welders are qualified under code for pressure piping ANSI B31.1.0
- Rigid conformance to specifications
- Airtight — watertight
- Inherent conduit strength permits shallow trenches
- Factory prefabricated for efficient field installation
- One order — Complete System
- Pre-determined costs
- Factory guidance of installation
- Factory certification of installation
- Meets labor and code requirements
- Approved by Department of Defense Tri-Service and other governmental agencies
- Most experienced supplier
- 4 plants guard against production interruptions

RICWIL PREFABRICATION

A Scientific Technique

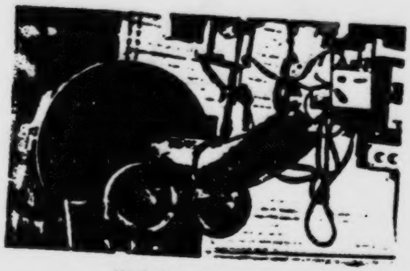
RICWIL, Incorporated, represents the modern scientific approach to the problem of insulating and protecting pipe distribution systems. RICWIL Insulated Piping is precision built on a mass production basis by expert workers in factories designed and equipped for this exclusive purpose.

RICWIL Units are engineered in correct basic design. All standardized parts are precision machine-made. RICWIL, Incorporated, supplies every type of unit, accessory and fitting, in the form of easily manipulated, job-handled segments, entirely prefabricated. The system is delivered complete and ready to install.

The construction of RICWIL systems conforms with working practice of trade unions in the field. Full cooperation with architects and engineers such as: complete drawings, installation literature, field service instructor and factory certification are available, if required.

Installation time and system cost to contractor and user are reduced to a minimum due to efficient factory fabrication, and an assured predetermined price and shipping date.

The success of this prefabricated system is proved by installations totaling thousands of miles of RICWIL Units rendering highly satisfactory and dependable service with minimum upkeep and maintenance.

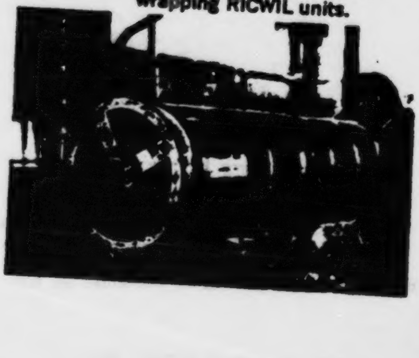


Welding 90° elbow fitting with submerged arc welder.

Welding mitered conduit for expansion loop.

Insulation of pipe elbow.

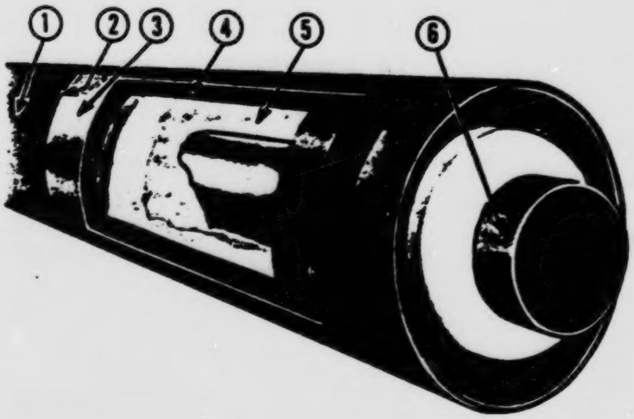
Skilled workmen, with specialized machines, coating and tension wrapping RICWIL units.



GALVA-GARD*

SMOOTHWALL

Galvanized Conduit



1. An outer wrap of asphalt impregnated fiberglass reinforced pipe line felt applied spirally under tension.
2. A machine coating of high melting point asphalt with an interposed layer of fiberglass screen.
3. 10 gauge galvanized spiral welded conduit.
4. Air space between conduit and insulation.
5. Insulation as specified.
6. Pipe as specified.

RICWIL Galva-Gard* Conduit is hot dip galvanized, both inside and outside, in the most modern galvanizing plant in operation today. The conduit is further protected by multiple machine applications of high melting point asphalt with an interposed layer of fiberglass screen and one final outer wrap of asphalt impregnated fiberglass reinforced pipe line felt applied spirally under tension.

Outside zinc coating is removed from terminal ends of units to provide a black steel surface on which the field connector bands will be welded.

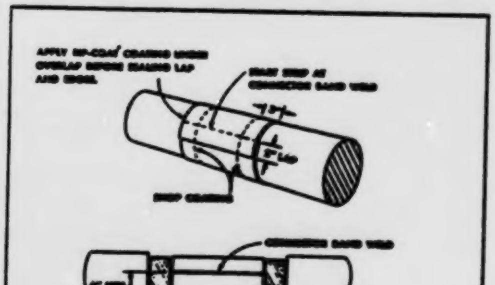
A single pipe, or any combination of multiple pipes, is accommodated in the conduit as required. Insulation type and thickness, in accordance with project specifications, is factory applied.

Pipe is supported by sturdy thermal insulating support-guides at regular intervals. Pipe is free to expand or contract in a longitudinal or lateral direction without wear or injury to the insulation or conduit.

The entire system is factory fabricated in 20′ or 39′ lengths as required. All accessories such as expansion loops, elbows, tees, anchors, and end seals are completely factory fabricated and shipped to the job site ready for immediate installation. The only field welding required is the connecting of straight sections of pipe and conduit to accessories and each other.

Note: 39′ length not applicable if largest size pipe in conduit does not exceed 2″ dia.

FIELD JOINT COATING PROCEDURE FOR ALL RICWIL GALVANIZED STEEL CONDUIT



For complete field joint coating procedures see Installation Manual.

Apply Rip-Coat Coating* evenly to all metal surfaces and lap about 1″ over the factory coating and allow to dry. Fill up all gaps, seams and crevices with Rip-Coat Coating* and Rip-Coat Blanket* between connector band and factory coating.

Liberally coat entire field joint area on one side of Rip-Coat Blanket* with Rip-Coat Coating*, then stretch and press blanket firmly into place.

*Trademark of RICWIL, INC.

SPECIFICATIONS

GALVA-GARD* Smoothwall Galvanized Conduit Systems

All steam, condensate returns, drip and discharge, hot water, oil or process piping, to be installed overhead or underground between manholes and buildings or between buildings, as shown on plans, shall be installed in RICWIL Galva-Gard* Galvanized Prefabricated Insulated Pipe Conduit, with all necessary fittings, anchors, expansion loops and conduit accessories, etc., as hereinafter specified.

1. CONDUIT — Conduit shall be 10-gauge smoothwall hot dipped galvanized steel having all outside surfaces of the conduit (except for overhead lines) machine-coated with high melting point asphalt to a minimum thickness of 3/16", with an interposed layer of fiberglass screen plus one final outer wrap of asphalt impregnated, fiberglass reinforced, pipe line felt applied spirally under tension.

Conduit closures shall be furnished with the conduit at a ratio of one closure for each fabricated item or length. Closures shall consist of 10 gauge steel suitably rust-proofed and in cylindrical form with a single horizontal split and shall be field welded over adjacent units. After test (paragraph 7) all exposed closures shall be covered in the field with Rip-Coat Coating* and Rip-Coat Blanket*. All materials and insulation required for complete field closure shall be furnished with the conduit.

2. PIPE AND PIPE SUPPORT-GUIDES — All piping in conduit shall be as hereinafter specified for the service required. All ferrous pipe field joints shall be welded by competent mechanics and hammer tested under hydrostatic pressure of 250 psig or one and one-half times the design pressure, whichever is greater. Concealed pipe welds in prefabricated conduit fittings shall be factory tested the same as specified for field welds prior to assembly.

Piping shall be suitably spaced and supported in conduit by specially designed full round insulating support-guides and shall permit the pipe to expand and/or contract freely without stress or wear on the pipe or insulation as well as provide for drainage and free air circulation.

3. EXPANSION LOOPS, ELLS AND TEES — Prefabricated ells, loops and tees shall be furnished and installed where shown on plans and shall consist of pipe, insulation, and conduit conforming to the same specification as hereinbefore specified for straight runs.

Expansion loops shall be of proper design in accordance with stress limits indicated by A.S.M.E. Code for pressure piping, District Heating Section. Loop piping shall be installed in conduit suitably sized to handle indicated pipe movement.

ALTERNATE: Where space does not permit the use of loops, expansion joints in manholes or bellows type expansion joints housed in conduit (similar in design to straight run) shall be provided.

4. END SEALS AND GLANDS — Terminal ends of conduits inside manholes, pits, or building walls shall be equipped with end seals consisting of a steel bulk head plate welded to the pipe and conduit. Where there is no anchor within five feet of a terminal end, conduits shall be equipped with gland seals consisting of a packed stuffing box and gland follower mounted on a steel plate welded to end of conduit. End seals or gland seals shall be equipped with drain and vent openings located diametrically opposite on the vertical center line of the mounting plate and shall be shipped to the job site with plugs in place. Terminate all conduits 2" beyond the inside face of manhole or building walls to protect any exposed piping insulation from damp-wall condensation.

5. LEAKPLATES — To provide an effective moisture barrier, conduits shall be equipped with leakplates in building or manhole walls — but only when there is an anchor plate within 5 feet outside the wall. Leakplates shall consist of a steel plate flange 4" larger in outside diameter than the conduit, welded to the conduit only and located in the wall approximately 6" from the end of the conduit. Wall sleeves are recommended where leakplates are not furnished.

6. ANCHORS — Prefabricated plate anchors shall be furnished and installed where shown on plans and shall consist of a steel plate welded to pipe and conduit. The steel plate shall be ⅜" thick for 6⅝" to 10¾" conduit, ½" thick for 12" to 22" conduit and ¾" thick for conduit over 22".

A concrete block shall be cast over the plate and conduit and shall be large enough for firm anchorage into undisturbed trench sidewalls and/or bottom. The concrete block to be at least 30" in length and extend a minimum of 9" beyond the top and bottom of anchor plate.

7. CONDUIT AIR TEST — All field welds at conduit closures shall be tested for leaks before applying Rip-Coat Coating* and Rip-Coat Blanket*. During test all field welds shall be checked with soap suds, and rewelded if necessary until air tight at 15 lbs. pressure.

The contractor shall furnish all necessary equipment and labor to perform the air test, including air compressor, gauges, conduit caps, temporary pipe and connections, etc. and complete the test to the satisfaction of the architect and/or engineer.

8. PIPE INSULATION — All pipe or pipes in conduit, shall be insulated as hereinafter specified.

9. MANUFACTURER'S FIELD INSTALLATION INSTRUCTOR— who is technically qualified to determine whether or not the installation is being made in accordance with the manufacturer's recommendation shall be present during critical periods of installation and test of the system. On completion of the installation, the contractor shall deliver to the owner a certificate from the manufacturer stating that the installation has been made in accordance with the manufacturer's recommendations.

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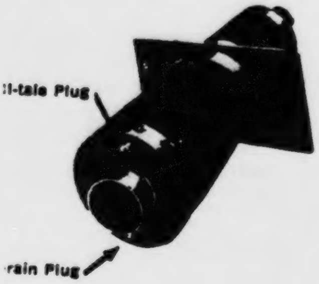
*Trademark of RICWIL, INC.

RICWIL PREFABRICATED ACCESSORIES

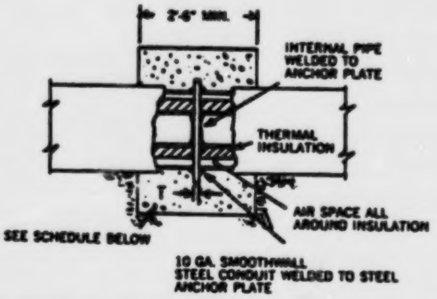
FOR STEEL CONDUIT SYSTEMS

RICWIL Incorporated provides every accessory needed for a complete piping system — expansion loops, elbows, tees, anchors, gland seals, end seals, watersheds, leak plates, etc. Accessory units are completely factory fabricated and insulated to conform with the type of straight run units specified for the individual system. They incorporate all of the same features, have the same inherent advantages and can be handled and installed with the same speed and ease, with a minimum of field work and cost.

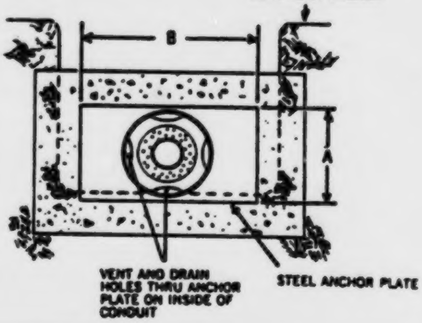

ll-tale Plug
rain Plug

ANCHOR PLATE AND END SEAL

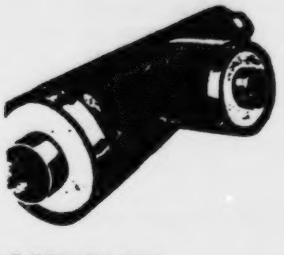
Anchor controls pipe movement due to expansion.


2'-6" MIN.
INTERNAL PIPE WELDED TO ANCHOR PLATE
THERMAL INSULATION
T
AIR SPACE ALL AROUND INSULATION
SEE SCHEDULE BELOW
10 GA. SMOOTHWALL STEEL CONDUIT WELDED TO STEEL ANCHOR PLATE

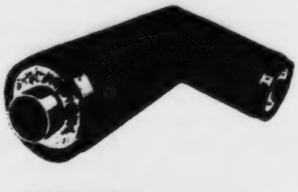
CONCRETE BLOCK (NOT FURNISHED) TO BE LARGE ENOUGH FOR FIRM ANCHORAGE INTO UNDISTURBED TRENCH WALLS, AND / OR UNDISTURBED TRENCH BOTTOM . . . MINIMUM 9" BEYOND TOP AND BOTTOM OF ANCHOR PLATE.


OUTLINE OF TRENCH
B
A
VENT AND DRAIN HOLES THRU ANCHOR PLATE ON INSIDE OF CONDUIT
STEEL ANCHOR PLATE

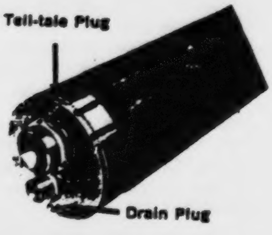
SCHEDULE OF ANCHOR PLATE SIZES (INCHES)															
Conduit Run Size (Corrugated)	6	8	10	11⅛	12	12⅜	15	16½	18	19½	21	24	..	..	..
Conduit Run Size (Smoothwall)	6⅝	8⅝	10¾	12	12¾	14	16	17½	19	20½	22	25	26	28	30
T	⅜	⅜	⅜	½	½	½	½	½	½	½	½	¾	¾	¾	¾
A	7	9	11¼	12¾	13½	14½	16½	18	19½	21	22½	25½	26½	28½	30½
B	15	17	19	20	21	22	24	25½	27	28½	30	33	35	37	39



E BRANCH UNIT



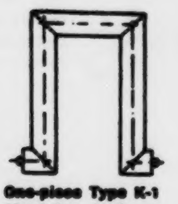
ELBOW UNIT


Tell-tale Plug
Drain Plug

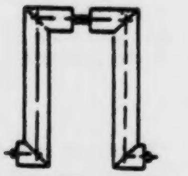
GLAND SEAL

XPANSION LOOPS

RICWIL Prefabricated Expansion Loops are available in two standard types. The basic designs are shown at right. Where space does not permit use of expansion loops, a completely prefabricated and insulated bellows type expansion joint, as illustrated — may be used.



One-piece Type K-1
Used for single or two-pipe combinations where overall dimensions will permit shipment in one piece.



Two or More Piece Type K-1A
For loops larger than K-1 which cannot be shipped in one piece. Average K-1A consists of two "Z" bends. Special-large loops may be made up of three or more units.

PIPE AND INSULATION DIMENSIONS

SEE PAGES 19 AND 20 FOR DETAILS ON SIZING VARIOUS CONDUIT SYSTEMS

PIPE SIZES		CALCIUM SILICATE					SECTIONAL FIBERGLASS HARD-PREFORMED					RICWIL FIBERGLASS Machine Molded-F.G. Screen Jacket				
		THICKNESS & O.D.'S					THICKNESS & O.D.'S					THICKNESS & O.D.'S				
Nom.	Bare O.D.	1"	1½"	2"	2½"	3"	1"	1½"	2"	2½"	3"	1"	1½"	2"	2½"	3"
¾"	1 1/16"	3"	4⅛"	5⅛"			2⅞"	4"	5"			2⅞"	4"	5"		
1"	1 5/16"	3⅜"	4⅜"	5 11/16"			3½"	4½"	5 9/16"			3 5/16"	4⅜"	5 5/16"		
1¼"	1 11/16"	3⅜"	5⅛"	5 11/16"			3½"	5"	5 9/16"			3½"	4 11/16"	5 9/16"		
1½"	1 15/16"	4⅛"	5⅛"	6⅜"			4"	5"	5 9/16"			3 15/16"	4 15/16"	5 9/16"		
2"	2⅜"	4⅜"	5 11/16"	6⅜"			4½"	5 9/16"	6⅝"			4⅜"	5⅜"	6⅜"		
2½"	2⅞"	5⅛"	6¾"	7¾"			5"	5 9/16"	6⅝"			4⅞"	5 9/16"	6⅜"		
3"	3½"	5 11/16"	6¾"	7¾"			5 9/16"	6⅝"	7⅝"			5½"	6½"	7½"		
3½"	4"	6¾"	7¾"	8¾"			6⅝"	6⅝"	7⅝"			6"	6⅝"	7⅝"		
4"	4½"	6¾"	7¾"	8¾"	9¾"		6⅝"	7⅝"	8⅝"	9⅝"		6½"	7½"	8½"	9½"	
5"	5 9/16"	7¾"	8¾"	9¾"	10 13/16"		7⅝"	8⅝"	9⅝"	10¾"		7 9/16"	8 9/16"	9 9/16"	10 9/16"	
6"	6⅝"	8¾"	9¾"	10⅞"	11⅞"		8⅝"	9⅝"	10¾"	11¾"		8⅝"	9⅝"	10⅝"	11⅝"	
8"	8⅝"	10¾"	11⅞"	12⅞"	14 3/16"	15 3/16"	10¾"	11¾"	12¾"	14"	15"	10⅝"	11⅝"	12⅝"	13⅝"	14⅝"
10"	10¾"		14 19/32"	15⅛"	16⅛"	17 3/16"	12¾"	14"	15"	16"	17"	12¾"	13¾"	14¾"	15¾"	16¾"
12"	12¾"		16⅛"	17 3/16"	18 3/16"	19¼"	15"	16"	17"	18"	19"	14¾"	15¾"	16¾"	17¾"	18¾"
Copper Tube																
Nom.	Bare O.D.															
¾"	⅞"	3"	4"				2⅞"	4"				2⅞"	3 15/16"			
1"	1⅛"	3⅜"	4"				2⅞"	4"				2⅞"	4⅜"			
1¼"	1⅜"	3⅜"	4½"				3½"	4½"				3⅜"	4⅜"			
1½"	1⅝"	4⅛"	4½"				3½"	4½"				3⅜"	4 15/16"			
2"	2⅛"	4⅛"	5"				4½"	5 9/16"				4⅛"	5⅜"			
2½"	2⅝"	4⅝"	5 9/16"				4½"	5 9/16"				4½"	5½"			
3"	3⅛"	5⅛"	6 11/16"				5 9/16"	6⅝"				5⅛"	6½"			
3½"	3⅝"						5 9/16"	6⅝"				5 9/16"	6½"			
4"	4⅛"						6⅝"	7⅝"				6⅛"	7⅛"			
5"	5⅛"						7⅝"	8⅝"				7⅛"	8½"			
6"	6⅛"						8⅝"	9⅝"				8⅛"	9⅝"			

RECOMMENDED INSULATION THICKNESSES

TEMPERATURE RANGES	NOMINAL THICKNESS		
	Pipes ¾" thru 3½"	Pipes 4" thru 6"	Pipes 8" thru 12"
0°F thru 34°F	2½" (V.S.)	2½" (V.S.)	2½" (V.S.)
35°F thru 60°F	1½"	1½"	1½"
61°F thru 338°F	1"	1"	1½"
339°F thru 388°F	1"	1½"	1½"
389°F thru 500°F	1½"	2"	2"
501°F thru 600°F	2"	2½"	2½"
			3"

(V.S.) We recommend that temperature range 0°F thru 34°F be vapor sealed.
For recommendations on temperatures below 0°F or above 600°F and pipe sizes exceeding 12", contact RICWIL Home Office.

ITT BARTON

PRODUCT BULLETIN 381C-1

Microprocessor Based Flow Totalizer

DELIVERY - 4 weeks

Product Description:

The ITT Barton Model 381C Flow Totalizer provides flowrate and totalized flow information corrected to base conditions, in actual engineering units on a single metering run. The microprocessor-based instrument accepts inputs from a wide variety of measurement elements such as Turbine Meters, Positive Displacement Meters, DP Transmitters, Static Pressure and Temperature Transmitters. It can perform a wide variety of flow computations including AGA-3 and AGA-5 gas-flow calculations, BTU, mass flow measurement and petroleum flow with a linear volume correction to API-2540. ITT Barton has substantial experience with microprocessor based flow totalizers and we back them up with field service and training.

Typical Applications:

1. Volumetric measurement of Flare Stack Gas.
2. Dual Differential Pressure measurement across a single orifice, venturi, etc.
3. L.P.G. Volume correction for temperature and pressure.
4. Mass flow measurement.
5. Turbine Meter prover, with volume correction for temperature.
6. Batching with control points.
7. Supercritical N_2 flow measurement.
8. BTU measurement.

Key Features:

The most accuracy from your system... — Gas volume/mass/energy flow computation based on AGA-3, AGA-5 or other flow models.

Easy to read... — Display 9 digit, 7 segment LED numeric with mnemonics.

Keyboard entry... — Calibration of analog input/output circuitry. Requires no internal adjustments.

— Engineering units, program constants and default values.

Security... — Field selectable Security Code prevents unauthorized access to program constants.

Power failures do not destroy totals or program constants... — Unpowered data storage up to 10 years of all calibration factors and flow totals. No battery required.

Isolation... — All analog input/output circuitry optically isolated.

On-site status reporting capability... — Outputs available for alarms, status and flow for input to telemetry or distributed control systems.

Minimize extra wiring and equipment... — Power supply capacity sufficient to drive all end devices.

More stable readings... — Superior noise rejection and filtering.

---

* NORMAL HAZARDS FOR 110V A.C. OPERATION.

ERAL SPECIFICATIONS

nput Signal capabilities:

our channels which may be configured as follows:

. Four analogs (4-20 ma)
2. Three analogs & one frequency
. Second input frequency available. High level input for Density Transmitter or other special functions & applications.

Output Signal capabilities:

1. Contacts, 3 sets (form 'C')
2. One analog (4-20 ma)
3. Five local status indicators

ENGINEERING SPECIFICATIONS

nput Signals:

. Signal type — square wave, frequency, current, pulse.
2. Frequency range: 10 Hz to 2K Hz.
. Threshhold 15mV RMS to 150 V RMS pulse width (50% Duty cycle).
. Input impedance — 50K ohms for signals below 300mV RMS, 6.6K ohms for signals above 300mV RMS.
5. Measurement accuracy: ±0.2% of rate.

nalog Inputs:

. 4-20 ma (pressure, temperature, differential pressure, density, specific gravity in any combination).
. Inputs can be operated optically isolated or referenced to signal ground.
. Input impedance — 10 ohms.
. Measurement accuracy: 0.1% of full scale.

Output Signals: (optically isolated)

1. 4-20 ma.
2. Optically isolated or referenced to signal ground.
3. Load resistance 0 - 1000 ohms total loop impedence.
4. Accuracy: ±0.2%.

Power supply adjustable from 20-32V DC at 100 ma.

Contact Output:

1. Type — single crossbar gold plated.
2. Contact configuration — Form 'C' (S.P.D.T.).
3. Contact rating AC rating 1.25 Amps at 125V AC resistive.
   DC rating 0.25 Amps at 150V DC resistive.

MICROPROCESSOR SAMPLING and UPDATE SPECIFICATIONS

1. Computation rate: one/second.
2. Input signal sampling rate: Frequency — once every two seconds.
   Analog — once every two seconds.
3. Display update: one/second.
4. Output signal update: Analog — one second.
   Alarms — one second.

ELECTRICAL REQUIREMENTS and POWER SUPPLY REQUIREMENTS

AC Operation: 95 - 130V AC 50/60 Hz.
205 - 240V AC 50/60 Hz.
DC operation: 12 VDC — User must provide power supply for end devices.
Power Consumption: AC operation — 15 watts.
DC operation — 12 watts.

ENVIRONMENTAL CHARACTERISTICS

1. Ambient temperature limits: 0°C - 70°C.
2. Relative humidity limits: 10% to 90%.
3. Temperature effect on accuracy 0.01%°C from reference temperature 25°C.

ENCLOSURES

1. Panel Mount.
2. Weather Proof — NEMA IV/NEMA XII.

CASE DIMENSIONS

Panel mount: 4¾ x 8 x 15 inches.
Panel cutout: 4⅝ x 6¾ inches.

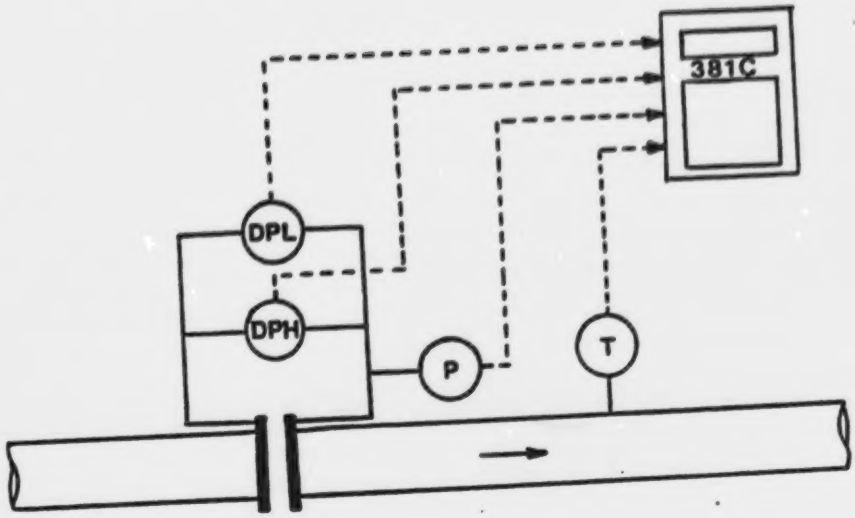
Weather Proof — 14 x 12 x 8 inches

ITT BARTON INSTRUMENTS
DIVISION OF ITT INDUSTRIES OF CANADA, LTD.
340 - 11A Street N.E.
lgary, Alberta, Canada T2E 6M6
lephone: (403) 276-8164 Telex: 038-21536

YOUR LOCAL REPRESENTATIVES

Sn drO 3.0 SYSTEM DESCRIPTION

Fig.2



The Dual Range Orifice system is illustrated above. The most common primary device is the orifice illustrated, but a flow nozzle, Annubar (R), elbow meter, or other head pressure element may be used.

In addition to performing the normal orifice flow calculations, the Dual Range mode of operation provides automatic range switching to allow more accurate flow measurement with a greater turndown ratio. The 381C automatically selects its input signal from whichever DP transmitter is giving a valid signal. The 381C does this by comparing the low range differential pressure input value to two programmed switching points.

If this capability is not required, a single range mode of operation can be selected. In this case the high range differential pressure input is used exclusively.

Although the program is designed for measurement of gasses, the drO program can also be used for measurement of liquids (with some restrictions). An example is given in Appendix I.

3.0 WOOD HANDLING SCENARIOS

3.1 GENERAL

The various steps of gathering wood fuel in the wood lot, and preparing the wood for input into the boiler system can be accomplished in a variety of ways. The various approaches use different combinations of equipment, afford different advantages and disadvantages, and have different costs. This section presents a brief analysis of alternatives and suggests the preferred wood handling approach.

Wood handling and preparation involves four generic steps: wood cutting, drying, chipping, and transport to the boiler site. Seven alternative scenarios are considered for the handling of felled timber in the wood lot. These eight are based on the following assumptions.

a) the log/fuel harvesting activity will be combined as much as possible in the wood lot with the harvesting of whole logs for log building construction or for sawmill timber. These alternate activities are part of other NDC business operations.

b) the final wood fuel product delivered to the boiler's fuel storage bin is dried wood chips.

c) the land required to store wood fuel to dry the fuel is available for free

d) chipping can be accomplished in town, or in the wood lot

e) the wood storage (drying) area is not immediately adjacent to the boiler plant

The eight handling scenarios are:

1. chip in the bush, haul chips to town, dry in town
2. chip at landings, haul chips to town, dry in town
3. chip at landings, dry in wood lot, haul chips to town

4. haul logs to town, chip, dry
5. haul logs to town, dry logs, chip to fuel bin
6. dry logs at landings, haul logs to town, chip to fuel bin
7. dry logs at landings, chip at landings, haul chips to fuel bin
8. (A modified #5) haul logs to town, dry logs, chip to dump truck, haul to boiler site.

Considerations to recognize in the course of the trade-off include:

a) the frequency of chipper blade sharpening (blade wear) and chipper maintenance increases in proportion to the dryness of the log to be chipped (wet wood is easier to chip, fire killed dry timber is very abrasive and wearing on chipper blades)

b) chipped wood tends to dry out faster than round logs

c) an unsheltered stack of logs resists rain water absorption (i.e. more hydrophobic) more than an unsheltered pile of wood chips

d) handling alternatives that use fewer different types of machines and equipment are preferred since scheduling complications are reduced, required capitalization is reduced, equipment utilization is better, the need to gainfully employ machines on other projects (to keep their charge out rates reasonable) to fill in slack time periods is reduced.

e) drying locations that guarantee access to the dry fuel as required all season long are preferred to locations accessable only in winter, only in summer, etc.

f) operations involving the use of equipment in town are preferred in order to reduce equipment and labour transport costs from base.

g) approaches that minimize the creation of fire hazards or risk of loss due to fire are preferred

h) approaches resulting in least cost for the supply of fuel are preferred

3.2 ANALYSIS OF ALTERNATIVES

For ease of comparison, salient features of the eight alternatives are tabulated in Table 3.2/1. The number of times the wood is handled, the equipment employed, and location of the work is tabulated for each alternative.

The costs developed here for each wood handling alternative are based upon full recognition of the costs for a business enterprise to harvest and provide chipped wood fuel; and allow for equipment depreciation, a return on investment on the assets used, and for reasonable wage levels. Typical cottage industry bid price levels provide no margin for equipment depreciation or equipment return. Consequently, the basis for any comparison of alternatives is consistent throughout, even though the prices themselves are higher than current cottage industry price levels in the community.

1. Chip (bush), Haul, Dry

In this harvesting scenario, trees are felled in the woodlot, delimbed and cut into man-totable sizes to carry as necessary to the nearest point of access to the chipper unit. The chipper is mounted on a trailer and pulled through the woodlot by the chip hauling dump truck. Trees and limbs are fed into the chipper manually. Chips produced are blown directly into the chip hauling vehicle. The crew produces and chips one 5-cord chip truck load per day for conveyance back to town. Chips are dumped into a storage area to dry. Air dried chips are later loaded by means of a front end loader into a dump box truck, transported the short remaining distance to the boiler plant, and dumped into the fuel bin.

This approach assumes that a front end loader is available for hire every few days to recharge the fuel silo. It is also assumed that the chipper and chip haul truck can move quite freely through the woodlot to get near to felled fuel timber. Costing for this alternative assumes the purchase of the wood chipper and chip haul truck. Costs for this scenario are presented in Table 3.2/2.

2. Chip (landing), Haul, Dry

This harvesting and handling approach is similar to "1" except that felled trees are not delimbed, and are dragged from the bush to open landing areas by a skidder machine. Trees are chipped at the landing site, with chips blown directly into the box of a chip haul truck. Cutting and skidding operations proceed independently of chipping and hauling. Chips are deposited at a storage site near town for drying. The chips are later loaded by bucket equipped front end loader into the haul truck and delivered to the boiler fuel bin.

The operation assumes the haul truck and chipper are purchased. The front end loader and skidder are rented. Costs for this approach are assembled in Table 3.2/2.

3. Chip, Dry, Haul

Fuel wood is felled in the bush and skidded to landing points by a skidder machine. The whole logs are chipped, and the chips are left at the landing for a few months to dry. Later the dry chips are picked up by bucket loader and loaded into the dump box of the haul truck for cartage to the boiler plant site. A small open air stock pile of chips is maintained at the boiler plant site. A loader is used to periodically reload the boiler fuel bin from the stock-pile. Wood cutting and skidding operations are independent from chipping and hauling operations.

A chip hauling dump truck and chipper are purchased; skidder and front end loader are rented. Costs for this alternative are assembled in Table 3.2/3.

4. Haul, Chip, Dry

This approach calls for whole logs to be loaded in the woodlot and carried to storage in or near town. Trees are felled and dragged to an open landing area by skidder machine. Logs are cut to 18' lengths at the landing and delimbed as necessary at the landing for ease of cartage. A grapple claw equipped hydraulic crane, fitted on the hauling truck is used to load 7 - 8 cords into the deck of the truck. The logs are hauled to a site near town. Green logs are chipped, with the chips left in windrows to air dry. Later, dry chips are loaded into the box of a dump box truck, by front end loader, and the chips are transported the remaining short distance to the boiler fuel bin.

The operation assumes the purchase of the wood chipper and rental of the skidder, loader, haul vehicle and dump truck. Costs for this alternative are assembled in Table 3.2/3.

5. Haul, Dry, Chip

The woodlot activities of this scenario match those of alternative #4. Whole logs are carried to a storage area near the boiler site and offloaded for storage and drying. Later, whole logs are loaded onto the crane equipped flat deck truck, and carried a short distance to the boiler site as required. The dry logs are chipped directly into the boiler fuel bin.

This operation assumes the chipper is purchased, the skidder and log haul truck is rented. Costs for this approach are presented in Table 3.2/3.

6. Dry, Haul, Chip

Whole logs are skidded from the woodlot and stacked at landing points to dry. Dry logs are later loaded and carried into town directly to the boiler site in small batches (two weeks supply). Whole logs are chipped directly into the boilers fuel wood storage bin.

This operation assumes the purchase of a chipper, and the contracting for a log haul truck and skidder.

7. Dry, Chip, Haul

Felled logs are skidded to the landing and stacked to dry using the crane/log haul truck. Dry logs are chipped in the woodlot in batches, hauled to the boiler site by dump box truck, and deposited in a stockpile (perhaps 1 - 3 weeks supply). Chips are loaded to the fuel bin as required by bucket loader.

The scenario assumes a wood chipper and haul truck is purchased, all other equipment is contracted.

8. Haul, Dry, Chip, Haul

This scenario is a modified scenario #5 where whole logs are carried to a storage area near the boiler site and off-loaded for storage and drying. Later, whole logs are chipped and blown directly into the dump box of a chip haul truck, carried the short distance to the boiler plant, and dumped into the fuel bin. Chipping would be an intermittent operation over the heating season, at times and quantities dictated to fill the boiler storage bin. This scenario offers the advantage that, while fuel is dried at an accessable location, chipping is performed at a location where noise objections would not occur.

CONCLUSIONS

1. The dry, haul, chip scenario (#6) should be followed in cases where the woodlot storage area will be accessable all winter without risk to security of supply to the boiler.

2. In cases where winter access cannot be guaranteed over long periods, the haul, dry, chip approach (#5) should be followed.

3. Handling wood in log form is generally less expensive than in chip form.

TABLE 3.2/1

WOOD FUEL SUPPLY ALTERNATIVES

ALTERNATIVE	# OF LOG PICKUPS	# OF CHIP PICKUPS	BUCKET LOADER LOCATION	WOOD STORAGE LOCATION	CHIPPER LOCATION	HAULED MAT'L	DUMP TRUCK REQUIRED	LOG TRUCK REQUIRED	COST PER CORD	COMMENTS
1. chip (bush), haul, dry	1-M	1	L	L	F	C	YES-2	NO	$112.43	chipper on standby for excessive periods
2. chip (landing), haul, dry	1-S 1-M	1	L	L	F	C	YES-2	NO	101.70	skidder used
3. chip, dry, haul	1-S 1-M	1	F	F	F	C	YES-1	NO	113.58	standby costs for dry chip loader are significant
4. haul, chip, dry	1-S 1-H 1-M	1	L	L	L	L	YES-1	YES-1	103.24	dump truck and loader costs are reduced
5. haul, dry, chip	1-S 2-H 1-M	0	-	L	L	L	NO	YES-2	93.96	chip to fuel bin is least handling, log handling is cheaper than chip handling
6. dry, haul, chip	1-S 2-H 1-M	0	-	F	L	L	NO	YES-1	92.14	least wood handling option, assumes wood lot is accessable as required
7. dry, chip, haul	1-S 1-H 1-M	0	-	F	F	C	YES-1	YES-1	100.52	idle time for chip haul truck, while loading, results in cost increase over #6
8. haul, dry, chip	1-S 1-H 1-M	0	-	L	L	L	YES-1	YES-1	103.11	more costly than #5 due to idle time of chip haul truck

M = manual feed
S = skidder
H = hydraulic claw, crane

L = local
F = field

C = chips
L = logs

YES - # of separate hauls from woodlot to fuel bin

TABLE 3.2/2

WOOD COLLECTION COSTS - Options 1 and 2

	- 500 cords per year scale of operation	
ITEM	ALTERNATIVE 1	ALTERNATIVE 2
1. Fuelwood Resource Depletion Charge ("stumpage") - $0.05/m^3$	$ 90.00	$ 90.00
2. Allowance for Reforestation - no imposed requirement	-0-	-0-
3. Allowance for Winter Roads, Cutting Trails, etc. - $1,000/km	2,000.00	2,000.00
4. Cutting - felling, delimb, cut into totable lengths - $20.00/cord (ref. 2) - incl. labour, saws, O & M	10,000.00	3,000.00 (felling only)
5. a) Tote and Stack at Chipping Points - $11.35/cord (ref. 2)	5,675.00	-0-
b) Skid to Landing - ($110./hr) skid 75, 5" dia., 30' logs/hr		6,500.00
6. Chipping (rate of 5 cords/hr)		
o labour ($14.00/hr)	1,400.00	1,400.00
o helper ($10.00/hr)	-0-	1,000.00
o fuel	600.00	600.00
o blades	200.00	200.00
o depreciation and repairs	4,000.00	4,000.00
7. Haul to Local Storage		
o labour	1,400.00	1,400.00
o fuel	3,000.00	3,000.00
o haul truck - depreciation, repairs, expenses	5,000.00	5,000.00
8. Storage Costs	1,250.00	1,060.00

ITEM	ALTERNATIVE 1	ALTERNATIVE 2
9. Storage Pick-up and Delivery to Fuel Bin		
o dump truck - labour	700.00	700.00
- fuel	500.00	500.00
- depreciation, repairs, etc. (sec. 7)	-0-	-0-
o loader ($100/hr)	5,000.00	5,000.00
TOTAL	$ 40,815.00 or $81.63/cord	$ 35,450.00 or $70.90/cord
10. Non-Operating Costs		
o mark-up on operations - allow	nil	nil
o administration allow.	$ 1,500.00	$ 1,500.00
o return on Investment on Assets employed @ 20%		
Asset Value:		
Truck - $45,000		
Chipper - 23,000		
Saws - 1,500		
$69,500 @ 20%	13,900.00	13,900.00
SUB TOTAL	$ 15,400.00 or $30.80/cord	$ 15,400.00 or $30.80/cord
TOTAL	$112.43/cord	$101.70/cord

TABLE 3.2/3

WOOD COLLECTION COSTS - Options 3 through 8

- 500 cords/year scale of operation

ITEM	ALTERNATIVE 3	4	5	6	7	8
1. Fuelwood Resource Depletion Charge ("stumpage") - \$0.05/m^3	\$ 90.00	\$ 90.00	\$ 90.00	\$ 90.00	\$ 90.00	\$ 90.00
2. Allowance for Reforestation	-0-	-0-	-0-	-0-	-0-	-0-
3. Allowance for Winter Roads, Cutting Trails, etc. - \$1,000/km	2,000.00	2,000.00	2,000.00	2,000.00	2,000.00	2,000.00
4. Felling	3,000.00	3,000.00	3,000.00	3,000.00	3,000.00	3,000.00
5. Skidding	6,500.00	6,500.00	6,500.00	6,500.00	6,500.00	6,500.00
6. Delimb, load and haul logs						
o delimb	-0-	3,000.00	3,000.00	3,000.00		3,000.00
o load		800.00	800.00	800.00		800.00
o haul/unload (\$120.00/hr)		12,800.00	12,800.00	12,800.00		12,800.00
o stack for drying				3,600.00	3,600.00	3,600.00
7. Chipping	7,200.00	7,200.00	7,200.00	7,200.00	7,200.00	7,200.00
8. Pick-up chips in Woodlot to Haul to Boiler Site						
o loader @ \$100.00/hr.	10,000.00	-0-	-0-	-0-	-0-	-0-
o hauling	9,400.00	-0-	-0-	-0-	9,400.00	-0-
9. Storage Costs	700.00	1,300.00	1,190.00	680.00	570.00	1,190.00

	ALTERNATIVE					
ITEM	3	4	5	6	7	8
10. Pick up and Delivery to Fuel Bin						
o loader @ $100/hr.	2,500.00	5,000.00	-0-	-0-	2,500.00	-0-
o dump truck @ $70/hr.	-0-	3,500.00	-0-	-0-	-0-	5,000.00
o log haul truck	-0-	-0-	4,000.00	-0-	-0-	-0-
SUB TOTAL	$41,390.00 or $82.78/cord	$45,220.00 or $90.44/cord	$40,580.00 or $81.16/cord	$39,670.00 or $79.34/cord	$34,860.00 or $69.72/cord	$45,180.00 or $90.31/cord
11. Non-Operating Costs						
o mark-up on operations	-0-	-0-	-0-	-0-	-0-	-0-
o administration	1,500.00	1,500.00	1,500.00	1,500.00	1,500.00	1,500.00
o return on investment on assets employed @ 20%						
Asset Value						
Truck - $45,000	*				*	
Chipper - 23,000	*	*	*	*	*	*
Saws - 1,500	*	*	*	*	*	*
$69,500 @ 20%	13,900.00	4,900.00	4,900.00	4,900.00	13,900.00	4,900.00
SUB TOTAL	$15,400.00 or $30.80/cord	$ 6,400.00 or $12.80/cord	$ 6,400.00 or $12.80/cord	$ 6,400.00 or $12.80/cord	$15,400.00 or $30.80/cord	$ 6,400.00 or $12.80/cord
TOTAL	$113.58	$103.24	$93.96	$92.14	$100.52	$103.11

4.0 CAPITAL COSTS

The capital costs to proceed from this point forward to the erection and start-up of the complete wood boiler heating system are assembled in this section. The assembled costs are those faced by the F/S NDC for this project.

The costs include amounts to modify the piping and controls in the client buildings as required. The costs do not include any amounts for any expenditures by the F/S NDC to arrange financing for the project, perform business planning or hire operating staff. The wood harvesting, storage, chipping and delivery of the wood fuel to the boiler plant is considered as a separate business venture or division of the F/S NDC. The cost for capital equipment for the wood harvesting, chipping, storage and delivery are accordingly not assembled in this Table. All of these wood harvesting costs are built into the chipped wood fuel price developed in Section 3.0, and used as a basis for economic viability calculations in Table 5.2/1 to follow.

TABLE 4.0/1 FORT SMITH SCHOOL DISTRICT
WOOD BOILER SYSTEM
CAPITAL COSTS

#		DESCRIPTION	COST
1.		Turnkey supply and erection of 7.0 M BTU/hr wood boiler plant and building, consisting of: - one 7.0 M BTU/hr wood fired, low pressure steam boiler - 4.9 x 7.3 x 3 m concrete walled wood chip storage bunker - screw auger type chip conveyance system - boiler feed stoker - 300 mg/m^3 ash separation system - induced draft fan assembly - 66 cm x 10 m free standing steel chimney - 7.3 x 9.7 m steel frame building with concrete foundation and floor - miscellaneous pumps and piping - shipping, installation, erection and start-up of the above.	$250,000.00 (1)
2.		Underground Distribution System	
	a)	to J.B. Tyrrell Elementary School	
		- material	$ 52,760
		- labour	$ 32,310
	b)	to Breynat Hall	
		- material	$ 4,313
		- labour	$ 2,700
	c)	to P.W. Kaeser High School	
		- material	$ 58,561
		- labour	$ 36,360
		Includes the purchase, shipment and burial of insulated pipe, pressure testing, road crossing, backfill and restoration of grounds.	

TABLE 4.0/1 (cont'd)

FORT SMITH SCHOOL DISTRICT
WOOD BOILER SYSTEM
CAPITAL COSTS

#	DESCRIPTION	COST
3.	Building Tie-Ins and Modifications	
a)	J.B. Tyrrell	
	- material	$ 13,933
	- labour	$ 11,875
b)	Breynat Hall	
	- material	$ 13,938
	- labour	$ 11,875
c)	P.W. Kaeser High School	
	- material	$ 15,325
	- labour	$ 12,500
d)	Boiler Plant	
	- material	$ 15,313
	- labour	$ 2,750
	Sub Total 2 - 3	$284,518 (2)
	Includes tie-ins and replumbing of existing boiler facilities, foundation wall entry, piping materials, heat exchangers, steam traps, condensate receivers, controls modifications, etc., as specified.	
4.	Municipal sewers tie-in	
	- electricity, sewer, water	$ 39,000
5.	Distribution System Contract Supervision	$ 27,000
	- tender package assembly and issuance	
	- tenders review and contract negotiation	
	- contract monitoring and contractor supervision	
6.	Boiler Facility Contract Supervision	$ 11,000
	TOTAL	$611,518

Notes:

1. Turnkey price is based upon a written proposal by a boiler system supplier.
2. Estimates by Winkelaar Howard & Associates Ltd.
3. General
    a) prices are estimated to apply to the 1985 summer construction season.

5.0 ECONOMIC VIABILITY ANALYSIS

5.1 PRESENT BUILDINGS OPERATIONS COSTS

The estimated costs to operate the GNWT buildings to be served by the proposed wood boiler heating system are assembled in this section. Fuel oil consumption information from 1983-84 was provided by DPW. Additionally, an analysis of other building operating costs for 1981-82, assembled by DPW, was reviewed.

The estimated operating costs for the buildings with fuel oil based heating systems are assembled in Table 5.1/1, with costs adjusted to 1985 dollars. The boiler operators' times are apportioned among 28 boilers and building heat distribution systems around the Town. The apportioned time shown in Table 5.1/1 is significantly variable from year to year based upon minor operating problems or maintenance actions that may occur.

Charges for water, electricity, materials, and maintenance trades labour to the building boiler system in each building reflect the operators judgement as to the portion of the total billing that could be applied to the boiler operation. The cost information was assembled from DPW internal maintenance work orders and other cost records.

TABLE 5.1/1 BUILDING ANNUAL OPERATING COSTS (1)

#	DESCRIPTION	JBT ELEM.	PWK MT.AVENS	BREYNAT HALL	TOTAL (4)
1.	Heating fuel oil 1983-84 qty (litres)	120,064	158,389	132,050	410,503
	1983-84 HDD(°C)				6,379
	Long term Avg. HDD (°C)				8,000
	Estimated average fuel consumption (litres)	150,600	198,600	165,600	514,800
	@ current fuel oil price (38¢/ltr/)				
	equals Long term average fuel oil cost (1984-85 price level) ($)	$57,228	75,468	62,928	$195,624
2.	Boiler Operators (3) 1981-82 manhours @ $23/hr (1984-85 DPW chargeout rate)	166	190	277	
	equals Allocated operators cost ($)	$ 3,833	4,387	6,396	$ 14,616
3	Heating System Water Consumption ($)	$ 228	725	(2)	$ 1,200
4	Heating System Electricity Consumption	$ 1,521	1,950	-	$ 5,000
5	Maintenance Materials	$ 1,248	1,063	-	$ 3,400

TABLE 5.1/1
(cont'd)

BUILDING ANNUAL OPERATING COSTS (1)

#	DESCRIPTION	JBT ELEM.	PWK MT.AVENS	BREYNAT HALL	TOTAL (4)
6	Other Maintenance Trades Labour	$ 6,421	6,495	-	$ 19,000
7	Operator's Vehicle - allocated share of capital cost, fuel and maintenance charges				$ 3,000
	TOTALS	$71,479	91,008		$241,840 (4)

Notes:

(1) costs adjusted to 1984-85 price levels

(2) building operations abnormal due to fire

(3) the manhour at locations are reported highly variable from year to year. The chargeout rate is a blended rate reflecting wages and employee benefits for all trades staff.

(4) an approximate figure with missing Breynat Hall data estimated by general comparison with the other buildings.

5.2 ESTIMATED CENTRAL WOOD BOILER SYSTEM OPERATING AND MAINTENANCE COSTS

The operating and maintenance costs associated with the continued operation of a central wood boiler heating system are assembled in Table 5.2/1. The costs are based upon a system configured to serve all three loads; J. B. Tyrrell Elementary School, P.W. Kaeser High School and Mt. Avens Residence, and Breynat Hall. The costs are generally not partitioned for each load separately since these costs are not highly variable in aggregate as a function of heat output. Ideally, the various costs would be assembled on a per-heating load basis in order to permit an incremental analysis of the viability of adding each load, in turn, to the central heating system.

Two boiler system operators are planned to supervise the wood boiler facility and both are assumed to be necessary even if one heating load only is served. The operators are costed at the current DPW boiler operators rate which includes wages and benefits, but no other overheads or allocations.

The costs are assembled/identified as if the wood boiler operation is a separate business activity with all costs specifically recognized and allocated as best as possible. Accordingly, the assigned cost of wood chip fuel accounts for the real costs of a wood harvesting business, allows for a return on investment and depreciation of the assets employed. The cost is, therefore, in excess of that currently charged in the fledgling and unsophisticated cottage wood fuel supply industry in Fort Smith.

System maintenance costs were estimated on the basis of the capital cost of the facilities; 4% per annum for the boiler system, 2.5% per annum for the distribution system and terminal heat transfer equipment.

TABLE 5.2/1 WOOD BOILER ANNUAL OPERATING AND MAINTENANCE COSTS

#	DESCRIPTION	JBT ELEM.	PWK MT.AVENS	BREYNAT HALL	TOTAL (4)
1	Wood fuel (1)				
	- air dried cords	244	322	268	834
	- cost @ $93.96/ cord (2)	$22,926	30,255	25,181	$78,362
2	Boiler operators 2 x 2080 hrs/yr @ $23.09/hr				96,054
3	Heating System Water Consumption (3)				1,200
4	Heating System Electricity Consumption				5,800
5	Maintenance Materials and Sub-contracted Trades Labour				
	- boiler plant				10,800
	- dist'n related	$ 2,800	3,100	800	$ 6,700
6	Operator's Vehicle (4)				$ 6,000
	TOTAL				$204,916

NOTES:

1) The quantity of wood fuel is computed based on the energy content of air dried jack pine to be 21.6 million BTU/cord. The energy content of fuel oil is taken to be 35030 BTU/litre, fuel oil boiler output efficiency to be 75%; and wood boiler output efficiency including distribution line losses is taken to be 68%.

2) The wood fuel cost per air dried, chipped and delivered cord is taken from Table 3.2/1.

3) the water and sewer costs were arbitrarily set to be similar to the current oil fired systems consumption.

4) Vehicle depreciation allowance included.

5.3 PROJECT ECONOMIC VIABILITY

The economic viability of the proposed central wood fired heating system is assessed by comparison of the operating costs between the existing situation and the wood heating system if implemented, and relating any net savings to the capital costs required to create the new facility. A number of methods can be employed to perform this comparison ranging from simple economic payback calculations to discounted cash flow analysis. Both are presented here.

Simply comparing the operating costs totalled in Tables 5.1/1 and 5.2/1 for the two alternatives, suggests that an annual operating cost saving of ($241,840 - $204,916) $36,924 is possible by adopting the wood fired heating system. For a capital investment of $611,518 (Table 4.0/1), the investment is paid back through operating savings in 16.6 years. This relatively poor viability indication was recognized some years ago, and has lead the F/S NDC to propose a somewhat different, and economically much more attractive package of goods and services to the GNWT. This package is as follows:

i) supply heat energy to J.B. Tyrrell Elementary School, P.W. Kaeser High School/Mt. Avens Residence, and Breynat Hall (as before);

ii) supply boiler supervision labour services for all equipment presently monitored by the existing two man DPW operating staff.

This concept has the effect of utilizing the F/S NDC operators much more completely, and accessing revenue to compensate for the two salaries that would otherwise be fully charged against the wood boiler operations. This concept has been favourably received by GNWT-DPW, and is the one considered for the balance of this viability assessment.

Simple Economic Payback Period

Comparing the costs assembled in Tables 5.1/1 and 5.2/1, the charges for operators and operators vehicles are adjusted to be equal under the revised "sales package". The operating savings of the wood boiler system therefore swell to $121,362 per year. This annual saving can be used to repay the $611,518 capital investment in 5.0 years.

It is possible to undertake the J.B. Tyrrell and Breynat Hall portions of the project and not do the P.W. Kaeser portion. Since a long distribution line is required to service the P.W. Kaeser load, the viability of the "three load" project may be less attractive than the "two load" project. This presumption proved to be false, as demonstrated by the calculations in Table 5.3/1. A project, constructed without the P.W. Kaeser load in place, would require an estimated $476,272 to build, and would create net operating savings of $72,041 per year over the current oil fired heating arrangement, resulting in a simple payback on investment of 6.6 years. If the P.W. Kaeser portion was now added to the "two load" project an extra $134,746 in capital is required, an extra $49,321/year operating savings result, and the total project payback improves to 5.0 years.

The viability calculations are, of course, sensitive to the assumptions behind the calculations. This sensitivity is illustrated by the following examples:

a) Wood fuel price - $103.11:
If the wood handling scenario #8 (Chapter 3) was adopted, a wood fuel price of $103.11 would prevail, as opposed to $93.96/cord. The annual project annual cost savings would be reduced to $113,731 from $121,362, causing an increase in the simple economic payback period to 5.4 years from 5.0 years.

TABLE 5.3/1 ECONOMIC VIABILITY OF PARTIAL PROJECT OPTIONS

	J.B.TYRELL & BREYNAT	P.W.KAESER	TOTAL
Avg. quantity of fuel oil consumed per year	316,200 l.	198,600 l.	514,800 litres
Cost of fuel oil @ 38¢/L. current rate	$120,156	75,468	$195,624
Equivalent quantity of wood chip fuel (1 cord - 21.6 M BTU = 616.6 ltr. fuel oil)	512 cords	322 cords	834 cords
Cost of Wood Fuel $93.96/cord	$ 48,107	$30,255	$ 78,362
Annual fuel cost saving	$ 72,049	$45,213	$117,262
Incremental labour costs	-	-	-
Incremental O & M savings (costs)			
- Electricity	(450)	(350)	$ (800)
- other	442	4,458	$ 4,900
TOTAL ANNUAL SAVINGS (A)	$72,041	$49,321	$121,362
Project Capital Cost			
- Boiler Plant	250,000	-	$250,000
- Dist'n System	161,772	122,746	$284,518
- Other - project management - boiler plant upgrades - miscellaneous	65,000	12,000	$ 77,000
(B)	$476,772	$134,746	$611,518
Simple Economic Payback Period (B/A)	6.6 yrs.		5.0 yrs.

b) Wood Fuel Price - $103.11
Fuel Oil Substituted - down 10%

If in addition to the situation in (a) above, the actual fuel oil quantity substituted was down 10% from forecast or 463,320 litres/year (i.e. 10% less energy was sold by the wood boiler plant than predicted), the net annual operating savings would be reduced to $94,169. The simple payback period would become 6.5 years.

c) All above, plus an extra $10,000/year O&M Cost

If in addition to the situation in b) above, the estimated O & M costs for the new facility were $10,000/year higher (33% higher) than assembled in Table 5.2/1 items #3-6, the net annual operating savings would become $84,169, resulting in an economic payback period of 7.3 years.

Discounted Cash Flow

The GNWT-DPW often use discounted cash flow analysis to assess the economic merit of capital expenditures, particularly if two or more possible investments are "competing" for implementation. In these instances, the cash flows that are projected over time for each alternative are discounted to their present value using a range of discounted rate (to judge present value sensitivity to discount rate). For projects of equivalent duration, the one with the highest net present value is generally preferred.

The real cash flows of the current oil fired heating operations are "lumpy" or high variable from year to year. A definitive cash flow analysis should recognize that the Liberty boilers in J.B. Tyrrell Elementary School will likely need retubing in the next few years, or complete replacement in the next 10-15 years, that the P. W. Kaeser 96 bhp boiler is in need of replacement now, that major circulation pumps often need replacement every 5-7 years, etc. The O&M expenditure estimate for the current facilities in Table 5.1/1 simply smoothed out the lumps in the small item expenses, and completely ignored the costs of the imminent replacement of major boiler equipment. Since the timing of these boiler replacements has a profound effect on calculated net present value (or cost in this case) of the current heating method, and since any assumptions about this timing are open to question, a detailed calculation of net present value of the current heating method was not undertaken.

It should be recognized that the following simplistic discounted cash flow analysis makes the wood boiler option look less viable than it really is, from the perspective of DPW, since their major costs for oil boiler replacement are avoided (presumably, if the units are taken out of service and used for very occasional standby operation, this will extend their calendar life time).

Ignoring the prospect of major oil fired boiler replacement, the difference between the O&M cash flow for a wood fired heating system and that for the current regime is an annual stream of savings of $121,362. If this is constant in real terms over time, then for an investment of $611,518 in year 0, returning $121,362 per year for a 20 year project lifetime, the investment has a net present value of $580,026 (discount rate is 58%) (or $1,037,828 for a 4% discount rate, or $294,983 for i=12%/year).

Alternatively, computing internal rates of return on the investment of $611,518, realizing $121,362 in annual returns results in:

i = 18.2% if project lifetime = 15 years
i = 19.2% if project lifetime = 20 years
i = 19.6% if project lifetime = 25 years.

That is, if an investment of $611,518 returns an annual amount of $121,362 for each year of a 25 year lifetime, a 19.6% compounded rate of return has been earned.

In summary, net present value calculations, and internal rate calculations on the simplified cash flow stream indicated that the wood fired heating system investment is a viable and economically preferred alternative to the current oil fired heating arrangement for most investors.

6.0 CONCLUSIONS AND RECOMMENDATIONS

The salient conclusions reached and recommendations offered due to the content of this work as summarized below.

CONCLUSIONS

Chapter 2.0

1. A number of wood boiler systems vendors exist in Canada that are capable of supplying the needs of this wood boiler installation on a turnkey basis.
2. Heat energy can be conveyed adequately in the installation by the use of low pressure steam.
3. An insulated, underground steam supply line, and condensate return line distribution arrangement is economically very similar in this case to surface run or overhead run distribution lines.
4. Distribution lines are quite expensive per unit length, and every effort should be made to place the boiler plant as close as possible to the loads served.
5. The distribution line routing illustrated in this report represents the optimal routing, given current ground level obstructions, cost considerations, and site access for future construction.

Chapter 3.0

1. Cottage industry wood fuel prices are lower than the prices properly charged by an ongoing business enterprise to recover their fully allocated expenses.

2. A wood harvesting scenario in which harvested logs are stacked to dry in the wood lot, later chipped directly into a chip hauling dump truck box and conveyed to the boiler site for immediate off load into the fuel storage bin is the most economical approach.

3. Wood harvesting scenarios in which wood is dried in log form and transported in log form are generally the least expensive scenarios.

Chapter 4.0

1. The capital cost of the central wood fired heating system as described herein is estimated to be $611,518.00.

Chapter 5.0

1. The economic viability of the facility is dependent on the efficient utilization of the wood boiler plant operators. The facility is not considered viable if the two assigned operators have no other responsibilities than to supervise the single wood boiler unit. The project is viable if the F/S NDC can contract out the operators to, in addition, supervise the rest of the Fort Smith boilers currently under DPW custody. On that basis, simple economic payback periods of 5-6 years are realizable.

RECOMMENDATIONS

1. If the F/S NDC can negotiate an energy sales agreement with the GNWT in which energy is purchased from the wood boiler facility at the same effective energy cost as fuel oil, the central wood boiler heating facility should be constructed.

7.0 FOLLOW-UP ACTIVITY PLAN

If the F/S NDC accepts the conclusions and recommendations of this report, the Activity Plan outlined below is offered as a guideline to direct follow-on actions.

1. Price Agreement

The first step to make the wood fired heating facility a reality is to negotiate an agreement with the GNWT to purchase heat energy. The agreement must prescribe the purchase of energy (gigajoules or BTU's) at the same net rate as the prevailing cost of heat energy derived from fuel oil. The agreement must also include the contract supervision by the F/S NDC boiler facility operators of all of the boilers in Fort Smith currently in DPW custody. Any detraction from these rules will extend the investment payback period or reduce the viability of the wood heating facility to the F/S NDC. Negotiations for the agreement can commence immediately.

2. Secure Approval for Locations/Routing

Preliminary/unofficial presentations to the Town of Fort Smith and various GNWT staff have uncovered no opposition to the selection and use of the land and the routing of the distribution lines as outlined in this report. However, to avoid future uncertainty, formal applications should be prepared to the Town and the GNWT specifically requesting approval to install a wood boiler facility and underground lines as intended. Negotiations and discussions should be set up in the near future with dedicated effort expended to gain approval prior to the start of step 4.

3. Notify GNWT Safety Division Boilers Branch

A letter outlining the intended project should be sent to the Boilers Branch. The letter should indicate the intended staffing plan for the wood boiler supervision and the supervision of other DPW boilers. A letter should be requested indicating compliance of the staffing plan with the GNWT Boiler and Pressure Vessels Ordinance.

4. Solicitation of Capital Financing

The Development Corporation must find $611,518 in capital funds, likely some interim financing on the capital funds cash flow, and likely some working capital financing to get the operation into business (until revenues can be generated on a sustained basis.) Firm construction and start-up dates must be selected. Proforma statements of income, balance sheet and operating cash flow must be prepared. Application for capital grants should be prepared to EMR-Remote Community Demonstration Program, DIAND - Economic Development, Special ARDA-DRIE, GNWT-EDA (for FY '86-87 and beyond). Special ARDA may also entertain the set-up of a separate wood chipper/harvesting business. Applications for capital debt, interim capital and working capital financing can be made through commercial lending agencies, and if necessary through high risk lenders or lenders of last resort, i.e. GNWT-Small Business Loan Fund. All financial supporting agencies will require the same nucleus of financial and project data on which to base their support.

Substantial effort must be made to assemble this financing and to fit the various players together to arrive at a fully financed, ready for construction condition.

5. **Secure any remaining approvals/permits**

6. **Tender Distribution**

   Once financing has been secured, review the distribution system specification document and incorporate any recent desired changes. Place the distribution system supply and installation contracts out to tender. Evaluate the tenders and select a contractor.

7. **Negotiate with Boiler Vendor**

   Negotiate a turnkey supply, erection and start-up contract with the preferred wood boiler system vendor.

8. **Construction**

9. **Staffing**

   Complete arrangements with the GNWT for the current plan to second DPW operating staff to supervise the wood boiler installation after start-up.

REFERENCES

1. J. Gilmour et.al " Fuel Wood Supply Area - Community of Fort Smith, N.W.T.," DIAND Timber Management, Fort Smith, 1983

2. Manecon Partnership "Rae-Edzo Community Wood Heating Conversion Study" EMR Canada, Yellowknife, NWT, 1984.

3. Manecon Partnership "Feasibility Study for a Central Wood Boiler Facility for Ft. Smith, NWT" Energy Conservation Division, DPW, GNWT, Yellowknife, NWT, 1982.

4. Manecon Partnership "Assessment of Selected Oil Fired Heating Equipment, Fort Smith, NWT," Energy Conservation Division, DPW, GNWT, Yellowknife, NWT, 1982.

APPENDIX A

BOILER FACILITIES

Draft
CALL FOR PROPOSALS

26 June, 1984

RE: CENTRAL WOOD BOILER HEATING PLANT

Dear

The Fitz-Smith Native Development Corporation intends to select a vendor for wood fuelled boiler equipment to supply and erect a complete wood boiler plant in Fort Smith, N.W.T. This letter is to provide information on the requirements for the installation, project status, and the vendor selection process. We invite your firm to submit a proposal for this supply and erection work.

BACKGROUND AND PROJECT STATUS

The Fitz-Smith Native Development Corporation Ltd. (NDC) is a Fort Smith based firm engaged in a variety of forest industry related endeavors. An agreement in principle has been reached between the Government of the Northwest Territories (GNWT) and the NDC on a concept in which the NDC would erect and operate a centrally located wood fired boiler plant and sell heat energy for building space heating needs to neighboring buildings owned by the GNWT. The Fort Smith buildings in question are J. B. Tyrrell Elementary School, Breynat Hall men's residence and food services facility, P. W. Kaiser High School and attached Mt. Avens women's residence. Heat would be supplied to each of the loads by means of insulated underground flow lines.

The economic and technical feasibility of this heating system concept was suggested from a preliminary study completed in 1982. The Native Development Corporation, with the support of Energy, Mines and Resources Canada, now plan to make a detailed economic and technical assessment of the project. To this end, an engineering consultant, Winkelaar, Howard and Associates Ltd., Edmonton, has been engaged to provide the engineering, technical and support services required to complete the general design of the distribution system to carry low pressure steam from the boiler plant to customer heat transfer points and to return condensate to the boiler plant. Secondly, a management consultant, Manecon Partnership, Edmonton, has been engaged to examine wood lot operations, and to advise on business aspects of the project.

BOILER FACILITIES VENDOR SELECTION PROCEDURE

The NDC intends to invite three prospective wood boiler suppliers to submit technical and cost proposals for the required facilities. Each of the vendors are invited to Fort Smith to examine the application first hand and to meet with a boiler facilities technical review group. The review group will consist of representatives from the GNWT Department of Public Works - Engineering Division, the Fitz-Smith NDC, and Manecon Partnership. At the review meeting, the intended application will be clarified to the satisfaction of the boiler facilities vendor, and the vendor will be asked to give a brief presentation and answer questions concerning his standard products, firm capabilities, and experience. The vendor will then be asked to supply a technical and cost proposal to meet the boiler plant requirements. Each candidate boiler facilities vendor will be permitted to charge the Fitz-Smith Native Development Corporation for costs incurred in connection with the site visitation and design analysis undertaken, up to limit of $3,000 per vendor firm.

The preferred boiler facilities vendor will be selected based upon the following selection criteria:

a) technical compliance with requirements
b) proven track record with the supply of similar installations

c) warranty and after sales technical support program, and previous track record

d) system documentation and operations training support provided

e) system price

The selection will be made the the review group.

If the economic viability of this project is reverified by the boiler vendor proposals and the results of the distribution design work, the NDC will arrange financing for the project, negotiate an energy sales agreement with the GNWT, and negotiate a contract with the preferred boiler vendor to supply and erect a heating plant facility.

PROJECT CONCEPT

The Fort Smith Central Wood Boiler Heating Plant is presently conceived as follows: Four institutional buildings, located in close proximity, are proposed to be heated by steam generated from a centrally located wood fired boiler plant. The boiler plant is to be equipped with two low pressure steam boilers each with an output supply capacity of 2,050 kw (7,000,000 BTU/hr). The condensate return and steam discharge lines are arranged to permit the operation of both units together, or each unit singly. A common wood chip storage and supply system is included to automatically charge the boilers with wood fuel in response to load demand. The wood chip storage bin or bunker is intended to have a capacity of 100 - 150 m^3 (3500 - 5300 ft^3).

Ash carried in the boiler flue gases will be removed by cyclone scrubbers or other suitable means in order to reduce plant particulate emissions to below 300 mg per standard m^3 of flue gas.

Low pressure steam is supplied by means of insulated buried flow lines to the boiler rooms of the designated buildings. Heat exchangers are installed in each building to transfer heat to the local distribution loops for conveyance throughout the building. Steam condensate is pumped back to the boiler plant from each building boiler room. Piping is to be arranged in each boiler room/to permit the present oil fired equipment to be brought into service on a back-up standby basis. The local distribution loops in each building presently are low pressure steam for J. B. Tyrrell Elementary School, low pressure steam for Breynat Hall, and hot water for P. W. Kaiser/Mt. Avens residence (P.W.K. and Mt. Avens share a common boiler room).

The layout of the distribution system running from the central wood boiler plant to the "client buildings" is not presently established.

PROJECT REQUIREMENTS

Your firm is requested to propose on the supply of goods and services as described in the attached Boiler Facilities Vendor Proposal Terms of Reference.

Each boiler vendor is invited to quote on his standard package of equipment that meets the intent of these requirements. Discussions and clarification regarding equipment configurations or alternative configurations proposed by a given vendor can take place at the review group session in Fort Smith.

BUDGET

As noted earlier, the Fitz-Smith Native Development Corporation Ltd. is prepared to assist your firm to defray the costs incurred in connection with the site visitation and for design analysis performed in support of the Terms of Reference up to a maximum limit of $3,000. You become eligible to claim upon submission of your equipment and cost proposal.

Questions regarding the project, or specifically relating to the boiler vendor selection process and boiler facilities proposals may be addressed to Mr. Rick Brommeland, P. Eng., Manecon Partnership, Edmonton, phone (403) 420-1527, or Mr. Dan MacDonald.

Yours truly

FITZ-SMITH NATIVE DEVELOPMENT CORPORATION

MR. DAN MacDONALD
President

DM/st

WOOD BOILER FACILITIES PROPOSAL

TERMS OF REFERENCE

The wood boiler facilities vendor is requested to propose on the supply of the following equipment and services in connection with the Fort Smith Central Heating Plant. The intent of the Fitz-Smith Native Development Corporation Ltd. is for the boiler facilities vendor to supply, erect and install all equipment and facilities that comprise the central wood boiler plant, including the plant building and its foundation. Design and construction of the distribution system, client building tie-ins, etc. are addressed to other contractors.

The proposal is requested to address the following points:

1. Specify and describe the complete wood fired low pressure steam boiler system including: two 2050 kw output capacity boilers; associated plumbing, piping manifolds, steam drums, etc.; condensate pumps and reservoirs; automated wood chip feed system (storage volume 100 - 150 m^3); water treatment equipment; flue gas ash removal equipment; system safety and operating controls; chimney and breeching; etc.

2. Describe the structural, foundation, mechanical and electrical requirements for the boiler plant needed to house the wood boiler and ancillary equipment proposed.

3. Prepare a physical layout sketch of the facility locating all process elements, and major piping runs.

4. Prepare a functional sketch to illustrate the boiler safety and operating controls proposed.

5. Provide your contract price schedule for the supply, erection, start-up and commissioning of the complete wood boiler facility described here, and for the building and subtrades to shelter the facility. Prices are to be valid for contract award by October 15, 1984.

APPENDIX B

TECHNICAL SPECIFICATION FOR STEAM DISTRIBUTION SYSTEM

FITZ-SMITH
NATIVE DEVELOPMENT
CORPORATION LIMITED

TECHNICAL SPECIFICATIONS
FOR
FORT SMITH
CENTRAL WOOD BOILER FACILITY
STEAM DISTRIBUTION SYSTEM

December, 1984

DRAFT

Prepared by:

Winkelaar, Howard & Associates Ltd.
11810 - Kingsway Avenue
Edmonton, Alberta.
T5G 0X5
Telephone: 452-2293

Project No. 1700

TRENCHING, EXCAVATING, BACKFILLING AND GRADING

SECTION 02220

GENERAL

.1 Work Included

- .1 Site survey and determination of routes and grades.
- .2 Trenching and trench backfilling.
- .3 Rough and finish grading of the site.
- .4 Furnishing and installing sand bedding around conduit system.
- .5 Repair of damage to asphalt roadways and concrete sidewalks.
- .6 Re-sod damaged areas.

2 Related Work

- .1 Repair of damage to asphalt roadways and concrete sidewalks.

3 Job Conditions

.1 Site Examination

The Contractor shall examine the site and be familiar withall objects which may affect the work in this section. No extra payment will be made for work resulting from a failure to know the existing conditions.

It shall be the Contractor's responsibility to conduct the required investigations to determine conditions which are likely to be encountered in undertaking the necessary work and to determine the quantities and nature of materials to be encountered in carrying out the work.

.2 Dust Controls

Use all means necessary to control dust on and near the Work and on and near all off-site borrow areas if such dust is caused by the Contractor's operations during performance of the Work or if resulting from the condition in which the Contractor leaves the site. Thoroughly moisten all surfaces as required to prevent dust being a nuisance to the public, neighbours, and concurrent performance of other work on the site.

.3 Protection

Use all means necessary to protect all materials of this Section before, during and after installation and to protect all objects designated to remain. In the event of damage, immediately make all repairs and replacements necessary to the approval of the Engineer and at no additional cost to the Owner.

1.4 Codes and Standards

.1 Local codes and bylaws.

.2 Workman's Compensation Board.

.3 National Building Code.

2. PRODUCTS

2.1 Fill Material, General

.1 Approval required: All fill mterial shall be subject to the approval of the Engineer.

.2 Notification: For approval of fill material, notify the Engineer at least four working days in advance of intention to import material, designate the proposed borrow area, and permit the Engineer to sample as necessary from the borrow area for the purpose of making acceptance tests to prove the quality of the material.

2.2 On-Site Fill Material

.1 All on-site fill material shall be soil or soil-rock mixture whic is free from organic matter and other deleterious substance. It shall contain no rocks or lumps over four inches in greatest diameter, and not more than 15% of the rocks or lumps shall be larger than 2 inches in greatest dimension.

2.3 Imported Fill Material

.1 All imported fill material shall meet the requirements of Articl 2.2 above and, in addition, shall be predominantly granular with maximum particle size of two inches and a plasticity index of 12 or less.

.4 Fill Beneath Foundations

.1 All fill material placed within two feet of the base of building foundations and/or slabs shall have a plasticity index of 15 or less.

.5 Granular Bedding

.1 Provide 6 inches minimum sand bedding under conduit, cover conduit system with a sand bedding of a minimum cover of 3 inches.

.1 Passing number 20 sieve:	100%

.6 Trench and Structural Backfill

.1 On-site fill material used for trench and structural backfill shall meet the requirements of Article 2.2 above.

.2 Imported cohesionless material used for trench and structural backfill shall be free from organic substance and other deleterious matter, shall be subject to the approval of the Engineer, and shall be in particle size grading within the following limits:

.1 Passing the number four sieve:	100%
.2 Passing the number 200 sieve:	3% Maximum

7 Other Materials

.1 All other materials, not specifically described but required for a complete and proper installation, shall be as selected by the Contractor subject to the approval of the Engineer.

EXECUTION

General

.1 Familiarization Prior to all work of this Section, become thoroughly familiar with the site, the site conditions, and all portions of the Work falling within this Section.

.2 Backfilling Prior to Approval

.1 Do not allow or cause any of the work performed or installed to be covered up or enclosed by work of this Section prior to all required inspections, tests, and approvals.

.2 Should any of the work be so enclosed or covered up before i has beenapproved, uncover all such work at no additional cos to the Owner.

.3 After the work has been completed, tested, inspected, and approved, make all repairs and replacements necessary to restore the work to the condition in which it was found at the time of uncovering all at no additional cost to the Owner.

3.2 Finish Elevations and Lines

.1 For setting and establishing finish elevations and lines, secure the services of a registered civil engineer acceptable to the Engineer. Carefully preserve all dta and monuments set by the civil engineer and, if displaced or lost, immediately replace to the approval of the Engineer and at no additional cost to the Owner.

3.3 Excavating

.1 Depressions: Where depressions result from, or have resulted from, the removal of surface or subsurface obstructions, open the depression to equipment working width and remove all debris and soft material as directed by the Engineer.

.2 Other areas: Excavate to grades shown on the Drawings. Where excavation grades are not shown on the Drawings, excavate as required to accommodate the installation.

.3 Overexcavation: Backfill and compact all overexcavated areas as specified for fill below, and at no additional cost to the Owner.

3.4 Preparation of Subgrade

.1 Scarifying After the site has been cleared, stripped, and excavated to within six inches of the specified depths for recompaction, scarify the exposed surface to a minimum depth of six inches, thoroughly moisture-condition, and compact to the requirements specified for fill below.

.2 Leveling Remove all ruts, hummocks, and other uneven surfaces by surface grading prior to placement of fill.

3.5 Excess Water Control

.1 Unfavourable weather Do not place, spread, or roll and fill material during unfavourable weather conditions. Do not resume operations until moisture content and fill density are satisfactory to the Engineer.

.2 Flooding Provide berms or channels to prevent flooding of subgrade. Promptly remove all water collecting in depressions.

.3 Softened subgrade Where soil has been softened or eroded by flooding or placement during unfavourable weather, remove all damaged areas and re-compact as specified for fill and compaction below.

.4 Dewatering

  .1 Provide and maintain at all times during construction, ample means and devices with which to remove promptly and dispose of all water from every source entering the excavations or other parts of the Work.

  .2 Dewater by means which will ensure dry excavations and the preservation of the final lines and grades of bottoms of excavations.

3.6 Backfill and Compaction

.1 Backfilling After subgrade compaction has been approved by the Engineer, spread approved fill material in layers not exceeding 6 inches in uncompacted thickness.

.2 Compaction

  .1 Hand tamp in 6 inch layers to 6 inches above top of conduit.

  .2 Do not use frozen, fill, sod, cinders or large stones as backfill.

  .3 Do not compact backfill with heavy wheeled or tracked equipment.

  .4 Backfill both sides of conduit simultaneously. Avoid injurious side pressures.

.3 Moisture-conditioning Water or aerate the fill material as necessary, and thoroughly mix to obtain a moisture content which will permit proper compaction.

.4 Compaction, General Compact each soil layer to at least the specified minimum degree. Repeat compaction process until grade is attained.

.5 Degree of Compaction Requirements

.1 Structural fill: Densify all structural fill, including recompacted existing fill and backfill, to a minimum degree of compaction of 90%.

.2 Pavement Areas: Compact the upper six inches of fill in pavement areas to minimum degree of compaction of 95%.

.3 Trench in Building and Pavement Areas:

.1 Building and pavement areas are defined, for the purpose of this paragraph, as extending a minimum of five feet beyond the building and/or pavement.

.2 Compact cohesive bckfill material to a minimum degree of compaction of 90%.

.3 Compact the upper six inches of backfill in pavement areas to a minimum degree of compaction of 95%.

.4 Densify cohesionless backfill material to a minimum relative density of 70% as determined by ASTM D2049.

.5 Compact materials of a questionable cohesion to either a minimum degree of cmpaciton of 90% or a minimum relative density of 70%, whichever results in the greater dry density.

3.7 Grading

.1 General: Except as otherwise directed by the Engineer, perform all rough and finish grading required to return the site to the original elevations.

.2 Grading tolerances:

.1 Rough grade:

.1 Building and parking areas: Plus or minus 0.1 foot

.2 Finish grade:

.1 Granular cushion under concrete slabs:	Plus or minus 0.1 foot
.2 Parking areas:	See Section 02612
.3 Landscaped areas:	See Section 02800

.3 Treatment after completion of grading:

.1 After grading is completed and the Engineer has finished his inspection, permit no further excavating, filling or grading except with the approval of the inspection of the Engineer.

.2 Use all means necessary to prevent erosion of freshly graded areas during construction and until such time as permanent drainage and erosion control measures have been installed.

.3 In the event of damage to such improements, immediately make all repairs and replacements necessary to the approval of the Engineer and at no additional cost to the Owner.

.4 Arrange bracing, sheeting, and shoring so as to not place stress on any portion of the completed Work until the general construction has proceeded far enough to provide sufficient strength.

.5 Removal of trench bracing: Exercise care in the drawing and removal of sheeting, shoring, bracing, and timbering to prevent collapse and caving of the excavation faces being supported.

.6 Grading and stockpiling trenched material: Control the stockpiling of trenched mateiral in a manner to prevent water running into the excavations. Do not obstruct surface drainage, but provide means whereby storm and waste waters are diverted into existing gutters, other surface drains, or temporary drains.

3.8 Foundation for Underground Distribution Conduit

.1 General: Grade the trench bottoms to provide a smooth, firm, and stable foundation free from rock points throughouit the length of the conduit run.

.2 Foundation Material: Place a minimum of six inches of the specified cohesionless material in the bottom of the trench.

.3 Subsurface Conditions: In areas where soft, unstable materials are encountered at the surface upon which cohesionless material is to be placed, remove the unstable material and replace it with material approved by the Engineer. Make sufficient depth to develop a firm foundation for the item being installed.

If the need for such overexcavation has een occasioned by an act or failure to act on the part of the Contractor, make the overexcavation and replacement at no additional cost to the Owner.

.4 Shaping: At each joint in transmission conduit recess the bottom of the trench as required into the firm foundation in such a manner as to relieve the conduit joint of all loads and to ensure continuous bearing of the conduit on the firm foundation.

Accurately shape all pipe subgrade and fit the bottom of the trench to the pipe shape. Use a drag template shaped to conform to the outer surface of the pipe if other methods do not produce satisfactory results.

3.9 Bedding for Underground Distribution Conduit

.1 General: Place the sandbedding as shown on the drawings.

.2 Densification: Densify the bedding material after placing by thoroughly saturating with water and vibrating with jetting equipment and a concrete vibrator stinger, at maximum intervals o two feet along both sides of the pipe.

Take special care to provide firm bedding support on the undersid of the conduit and fittings for the full length of the pipe.

3.10 Backfill for Underground Distribution Conduit

.1 Using on-site materials: After the conduit has been thoroughly bedded and ocvered, spread the on-site materail in uniform lits o not more than eight inches in uncompacted thickness, and then compact as specified in this Section. Repeat the spreading and compacting procedure until adjacent grade level is attained.

.2 Using imported cohesionless material: After the conduit has been thoroughly bedded and covered, fill the remaining portion of the trench with the specified cohesionless material, and densify as specified in this Section.

3.11 Grades and Elevations

.1 Site Plan is schematic only, Contractor to perform a site survey to accurately locate existing buildings, grades, and other features affecting the routing of the underground distribution conduit. Contractor to provide an As-Built drawing showing the above information and a proposed routing and grading for distribution system for approval by the Engineer.

3.12 Tunnel Under Corridor-P.W. Kaeser

.1 Contractor to tunnel uner corridor floor (slab on grade) using a boring machine or by hand excavation.

.2 Support floor slab as required during excavation & backfill.

.3 Mudjack if necessary to maintain adequate support of floor slab.

.4 Repair any damage to slab or corridor.

SECTION 02612

ASPHALT PAVING

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1. GENERAL

1.1 Work Included

.1 Restoration of all asphalt damaged by Contractor.

1.2 Related Work Specified in Other Sections

.1 Trenching, excavating, backfilling and grading: Section 02200.

1.3 Reference Standards

.1 ASTM Standards, Part 15.

1.4 Samples

.1 Take samples in acordance with the method of ASTM D979-74 (1979).

.2 Place aggregates in tightly closed containers to prevent contamination.

1.5 Protection

.1 Protect structures and buildings against damage caused by paving operations.

.2 Protect surface features, sidewalks and buildings against asphalt spray.

1.6 Definitions

.1 Prime Coat: An application of low viscosity liquid asphalt to an absorbent surface, used to prepare an untreated base for an asphalt surface.

.2 Tack Coat: Verylight application of liquid asphalt used to ensure bond between the surface being paved and the overlying course.

.3 Fog Seal: Light application of slow setting asphalt emulsion used to renew old asphalt surfaces and seal small cracks and surface voids.

.4 Slurry Seal: A mixture of slow setting asphalt emulsion, fine aggregate, mineral filler and water used to fill cracks and sealed areas of old pavements to restore a uniform surface texture and sea the surface.

.5 Sand Seal: An application of asphaltic material covered with fine aggregate used to improve the skid resistance of slippery pavements

.6 Asphalt Pavement: A high quality, thoroughly controlled hot mixture of asphalt and well graded, with quality aggregate.

2. PRODUCTS

2.1 Bituminous Materials

.1 Primer: MC-30.

.2 Tack Coat: SS-1 diluted with water.

.3 Fog Seal: SS-1h diluted with water.

.4 Slurry Seal: SS-1h diluted with water.

.5 Sand Seal: SS-1h.

.6 Asphalt Pavement: AC 2.5 to requirements of ASTM D3381-81.

2.2 Aggregate

.1 Crushed stone, crushed gravel, sand, mineral dust or a combination of these materials, conforming to the following gradation:

.1 19mm

Sieve Size	Percent Passing By Weight
Passing 19.0mm	90 - 100
Passing 9.5mm	62 - 86
Passing 4.75mm	40 - 67
Passing 2.36mm	24 - 45
Passing 0.425mm	10 - 30
Passing 0.150mm	5 - 20
Passing 0.075mm	2 - 8

.2 9.5mm Top Size

Passing 9.5mm	90 - 100
Passing 4.75mm	60 - 80
Passing 2.36mm	35 - 65
Passing 0.30mm	6 - 25
Passing 0.075mm	2 - 10

.2 Minimum of 60% by weight of the aggregate shall have one or more faces produced by fracture.

2.3 Fine Aggregate

.1 Clean sharp sand and mineral filler combined to meet the following gradation:

.1 For Slurry Seal

Sieve Size	Percent Passing By Weight
2.3mm	100
1.18mm	55 - 85
0.60mm	35 - 60
0.30mm	20 - 45
0.15mm	10 - 30
0.075mm	5 - 15

.2 For Sand Seal

Sieve Size	Percent Passing By Weight
4.75mm	100
2.36mm	15 - 45
1.18mm	0 - 10
0.30mm	0 - 5

2.4 Mineral Filler

.1 Portland Cement, Pozzolan, or commercially ground stone dust. Mineral filler shall have plasticity index of zero and comply with the following gradation:

Sieve Size	Percent Passing By Weight
0.60mm	100
0.30mm	95 - 100
0.075mm	70 - 100

2.5 Asphalt Pavement Mixture

.1 Asphalt paving: Hot plant mix consisting of crushed gravel aggregate, mineral filler if required and asphalt cement binder as specified in this section.

.2 Design mix in accordance with ASTM D3515-83, to meet the following Marshall Mix Design Criteria:

	Test Category	Value
.1	Number of blows per specimen	75
.2	Minimum Stability	3,336 N
.3	Flow (0.25mm)	8 - 16
.4	Percent air voids to mix:	
	Surface course	3 - 5
	Base course	3 - 8
.5	Percent voids in mineral aggregate:	
	19mm size	14
	9.5mm size	15

.3 Asphalt plant standards to ASTM D995-81.

.4 Asphalt mixes to be prepared according to ASTM D3515-83.

.5 Submit to the Engineer design mix formula for approval three (3) days prior to actual paving work in field. Proportions of the design mix shall not be changed during the work without submission of a new design mix formula.

2.6 Slurry Seal Mix

.1 Design mix to meet following criteria:

- .1 SS-1h 20% - 25% of weight of dry aggregate.
- .2 Water: 10% to 15% of weight of dry aggregate.

.2 Mixture: Prpared in slurry machine sufficiently fluid to flow into cracks when applied.

.3 Submit to the Engineer design mix formula for approval three (3) working days prior to actual placement in field. Do not change proportions of design mix during work without submission of new design mix.

2.7 Fog Seal Mix

.1 Mix SS-1h with water at ration of 1:1.

2.8 Tack Coat Mix For Overlays And Curbs

.1 Mix SS-1h with water at ratio of one part asphalt to three parts water.

3. EXECUTION

3.1 Base

.1 Examine prepared base before paving. Report defects in base to Engineer. Do not commence work if base is unsatisfactory.

3.2 Existing Asphalt Surface Cleaning

.1 Cleaning parking lot with mechanical sweeper to remove loose stones sand and dust before applying tack coat. Remove loose and foreign material completely from cracks.

.2 Spray asphalt areas to receive new asphalt with soil sterilant afte sweeping. Apply in accordance with manufacturer's instruction and authorities having jurisdiction.

3.3 Primer

.1 Apply primer at rate of:

- .1 0.90 L/m2 to 1.50 L/m2 for tightly grade surfaces.
- .2 1.2 L/m2 to 2.2 L/m2 for open graded surfaces.

.2 Allow primer to set until it is absorbed completely.

3.4 Tack Coat For Overlays And Curbs

.1 Clean existing pavement surface (and apply sterilant) immediately before application.

.2 Paint all vertical surfaces with SS-1h.

.3 Apply tack coat at rate of 0.25 L/m2 to 0.70 L/m2 with pressure distributor.

3.5 Asphalt Pavement

.1 Apply asphalt in compacted lifts of 50mm to a total thickness to match existing.

.2 Apply asphalt in lifts of 30mm laid to specified elevations and grades for overlay course.

.3 Compact to 100% of Marshall Design Density.

.4 Trueness of surface: 5mm maximum depression per 3.0 M.

3.6 Fog Seal

.1 Clean existing pavement surface (and apply sterilant) as specified.

.2 Apply fog seal at rate of 0.50 L/m2 with pressure distributor.

.3 Ensure coat is applied evenly.

3.7 Slurry Seal

.1 Clean existing pavement surface (and apply sterilant) as specified.

.2 Wet surface immediately before application of slurry mixture.

.3 Apply slurry mixture with spreader to depth not exceeding 8mm. Mixture must be applied evenly. Ensure penetration into scaled areas and cracks. Roll if necessary.

3.8 Sand Seal

.1 Clean existing pavement surface immediately before application.

.2 Apply SS-1h at rate of 0.60 L/m2 with pressure distributor.

.3 Apply sand uniformly at rate of 0.004 m3/m2 using mechanical spreader.

.4 Roll sand until smooth thoroughly compacted surface is obtained.

3.9 Curbs

.1 Clean pavement surface and apply tack coat.

.2 Construct asphalt curbs as follows:

  .1 In accordance with details on the drawings or detail sheets.

  .2 To mould pattern approved by the Engineer.

.3 Compact to 97% Marshall Design Density.

3.10 Line Markings

.1 Clean pavement surface.

.2 Paint lines straight and at uniform width with mechanical applicator or using line stencil.

.3 Rate: 2.5 m2/L.

.4 Line width: 100mm.

3.11 Roller Requirements

.1 No restrictions provided compaction requirements are met. For pneumatic-tire roller, the wheels shall not be of the wobbly type.

3.12 Traffic

.1 Keep vehicular traffic off newly paved areas until pavement surface temperature has cooled below 39 deg. C. No stationary loads shall b permitted on the pavement until 24 hours after placement

.2 Provide access to building at all times. Arrange paving schedule s as not to interfere with normal use of premises.

3.14 Clean-Up

.1 Remove loose asphalt and aggregate from site.

.2 Remove asphalt spillage from sidewalks and building walls.

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1. GENERAL

1.1 Work Included

.1 Restoration of all concrete damaged by Contractor.

1.2 Related Work Specified In Other Sections

.1 Trenching, excavating, backfilling and grading: Section 02200.

1.3 Detail Drawings

.1 Following detail drawings are expended hereto and form part of this Section.

Number	Title
02620-CE-2	Sidewalk & Swale Gutter Detail

1.4 Reference Standards

.1 Concrete Materials and Methods of Concrete Construction: CAN3-A23.1-M77.

.2 Methods of Test for Concrete: CAN3-A23.2-M77.

.3 Reference Standards listed are most recent edition of each.

1.5 Inspection

.1 Obtain Engineer's approval of formwork and reinforcing before placement of concrete commences.

2. PRODUCTS

2.1 Materials

.1 Portland cement: normal Type 10 to CAN3-A5-M83.

.2 Water, Fine and Coarse Aggregates: to CAN3-A23.1-M77.

.3 Admixtures: to CAN3-A23.1-M77.

.4 Curing Compound: Liquid membrane conforming to CAN3-A23.1-M77.

.5 Preformed Joint Filler: asphalt impregnated type to ASTM D1751-73.

.6 Poured Joint Filler: Asphalt elastic compound to ASTM D1190-74(1980).

.7 Welded Wire Fabric: 152mm X 152mm - MW 11.1 X MW 11.1 welded wire mesh to CSA G30.3-1972 (R1979).

.8 Reinforcing Steel: 10 M bars to CSA G30.12-M77.

.9 Forms: premanufactured and profiled steel forms, wooden or steel forms for curved sections.

.10 Form oil: non-staining mineral type.

.11 Parking Curb: as detailed on drawings.

.12 Pin: as detailed on drawings.

.13 Patio Block: Precast concrete, 600mm X 750mm X 45mm thick.

.14 Sand: Conform to requirements of Section 02201.

2.2 Mix

.1 Design concrete mix to produce 25 MPa at 28 days with maximum aggregate size of 25mm, 30mm to 80mm slump and 5% to 7% air entrainment.

3. EXECUTION

3.1 Subgrade

.1 Construct subgrade to elevation and grade specified.

.2 Compact subgrade to 95% Standard Proctor Maximum Dry Density.

.3 Excavate soft spots and fill with 50mm crushed gravel compacted to 95% Standard Proctor Maximum Dry Density.

3.2 Granular And Sand Cushion

.1 Place 50mm thick compacted sand cushion layer on prepared sub-grade.

.2 Keep sand cushion layer sufficiently moist to prevent absorption of water from freshly poured concrete.

.3 Place 50mm thick sand cushion for precast patio blocks.

.4 Place 50mm crusheed gravel.

3.3 Reinforcement

.1 Place reinforcing bars as detailed.

.2 Clean reinforcing free of loose rust and mill scale.

3.4 Concrete

.1 Place concrete in accordance with the requirements of CAN3-A23.1-M77 and vibrate by means of vibrating screed or pencil vibrator.

.2 Work concrete with wooden float and finally steel float or trowel. Avoid excessive trowelling.

.3 Finish with approved nylon brush pulled lengthwise along curb and gutter and pulled across width of the sidewalks.

.4 Remove face of curb forms after initial set of concrete and finish face of curb by trowelling and brushing.

.5 Expansion Joint at building face or other abutment: Place 15mm wide performed joint filler 5mm below finished surface for full width and depth of concrete.

.6 Contraction Joints: For sidewalks, curbs and gutters construct 35mm deep by 5mm wide joints every 3 M on centre by means of marking tool or other approved method.

.7 Surface Joints: On sidewalk surface, construct 15mm deep by 5mm wide joints every 3 M on centre between contraction joints by means of marking tool or other approved method.

.8 Edge Finishing: Finish outside edge of sidewalks and each edge of joints with 50mm wide edging tool having 6mm radius.

.9 Apply curing compound to finished surface immediately after floating in accordance with manufacturer's printed instructions.

.10 End all pours at construction joints. Place 10 M tie-bars at 300mm spacing and extending 300mm into both sides of joints.

.11 If mean daily temperature falls below 5 deg. C, provide cold weather protection as outlined in CAN3-A23.1-M77 and as approved by the Engineer.

3.5 Backfilling

.1 Backfill to match existing.

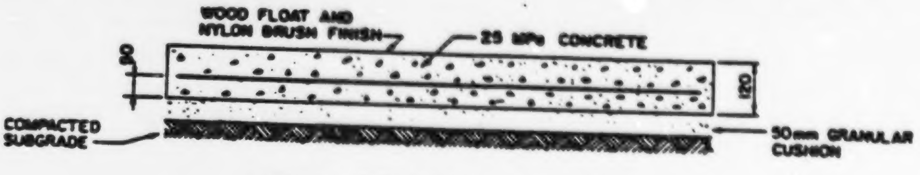
3.6 Tolerances

.1 Meet following criteria for exposed concrete surfaces:

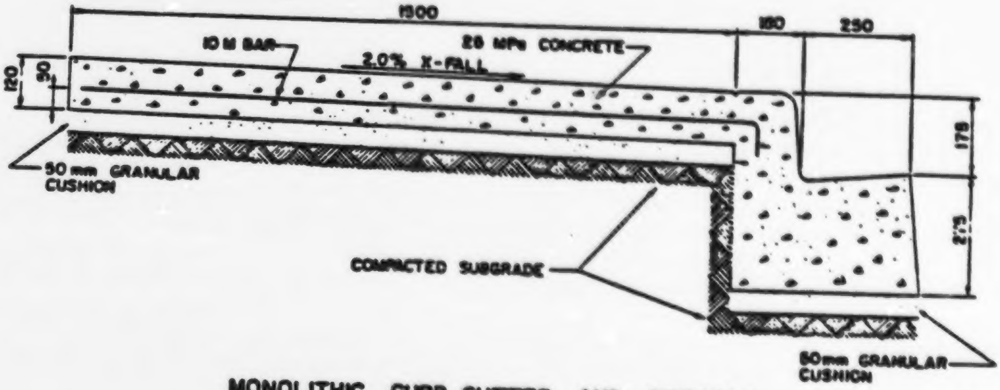
  - .1 Trueness of surface: 6mm maximum deviation in 3 M length.
  - .2 Elevation: approximately 15mm maximum deviation from existing.
  - .3 Alignment: aproximately 25mm maximum deviation from existing.

NOTE: ALL EDGES INCLUDING JOINTS TO BE TOOLED FOR A WIDTH OF 50mm AND THE CORNERS ROUNDED TO 6mm RADIUS

NOTE: 10M RODS PLACED TRANSVERSLY 100mm EACH SIDE OF EVERY JOINT


WOOD FLOAT AND NYLON BRUSH FINISH
25 MPa CONCRETE
50
120
COMPACTED SUBGRADE
50mm GRANULAR CUSHION

120mm STANDARD SIDEWALK


1500
160
250
10 M BAR
25 MPa CONCRETE
2.0% X-FALL
120
50
175
275
50mm GRANULAR CUSHION
COMPACTED SUBGRADE
50mm GRANULAR CUSHION

MONOLITHIC CURB, GUTTER AND SIDEWALK

SIDE WALK & GUTTER DETAILS

DATE DEC.5/1984	WINKELAAR, HOWARD & ASSOC. LTD. CONSULTING ENGINEERS EDMONTON CALGARY	JOB Nº 1700
DRAWN BY		
CHECKED BY		DWG Nº 02620-CE-2

GENERAL MECHANICAL PROVISIONS

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1. GENERAL

1.1 Work Included

.1 Requirements of the Contract Documents including all sections of Division 1 - General Requirements and any addenda.

.2 Co-ordination with other affected work.

1.2 Related Work

.1 Sections referenced in all Division 15 sections under "Related Work" and in the technical text.

1.3 Intent

.1 Provide complete operational mechanical systems with facilities and services to requirements described, in accord with applicable codes and statutes.

.2 Drawings are diagrammatic and approximately to scale. The contract documents establishing scope, material and quality and are not detailed installation instructions.

.3 Conform to manufacturer's instructions, details and procedures for equipment.

.4 Install equipment in locations and routes shown, close to building structure with minimum interference with other services or free space. Remove and replace improperly installed equipment.

.5 Provide labour and materials required to install, test and place into operation all mechanical systems. Provide additional labour and materials for modifications required to correct job conflictions.

.6 Provide connection of mechanical system to equipment furnished in other Sections, including uncrating, locating in place, installing, start-up and test.

.7 Examine the site and local conditions to determine the difficulties in carrying out the work indicated and specified prior to submitting final price.

.8 Remove from service the Cleaver Brooks Hot Water Boiler located in the P.W. Kaeser Mechanical Building and turn over to the Owner.

.9 Make all wall penetrations and tie-in connections for steam distribution piping at the Wood Chip Boiler Plant and at mechanical rooms of Breynat Hall Residence, J.D.Tyrrell Elementary School and P.W. Kaeser High School.

.10 Install the following in the Wood Chip Boiler Plant:

- metering run
- metering instrumentation for low pressure steam
- positive displacement flow totalizer for returning pumped condensate
- freeze alert alarm
- low pressure steam and pumped condensate piping up to tie-in connections

.11 Co-Operate fully with the Wood Chip Boiler Plant Contractor.

1.4 Materials

.1 Replace materials less than specified quality or as designated by Engineer and relocate work incorrectly installed as determined by Engineer.

.2 Materials and equipment installed shall be new, of the minimum quality specified. Statically and dynamically balance rotating equipment for minimum vibration and low operating noise level.

.3 Provide name/date plates on major component of equipment with manufacturer's name, model number, serial number, capacity data and electrical characteristics attached in a conspicuous place.

.4 Install materials and equipment with qualified trades people.

.5 Maintain uniformity of manufacture for equipment used in similar applications and sizes.

.5 Trenching, Excavation, Backfilling and Grading

.1 Refer to requirements of Section 02220.

.2 Perform trenching and excavation outside the buildings. Provide sand bedding to a minimum of 3" over the pipe conduit and 6" under the pipe conduit. Backfill with on site fill material. Remainder of excavation, backfilling and disposal of surplus material is specified in Section 02220.

1.6 Cutting and Patching

.1 Locate holes and provide sleeves, cutting and fitting required for mechanical work. Relocate improperly located holes and sleeves and repair work accordingly.

.2 Provide expansion bolts, hanger rods, brackets and supports.

.3 Do not alter structural members of building without obtaining prior written approval from Engineer.

.4 Perform patching of finished work in accordance with the applicable sections of specifications.

1.7 Semi-Final and Final Inspections

.1 Refer to Section 01300, Schedules.

.2 Refer to Section 01700, Contract Close-Out.

.3 Prior to semi-final inspection confirm, in writing, that the following work is completed:

  .1 Heating systems are capable of operation and automatic controls operate generally, but not finally calibrated.

  .2 Perform tests on equipment including those required by authorities and obtain approval certificates.

  .3 Valve tagging is complete, equipment is identified. Equipment and piping is painted.

  .4 Equipment is lubricated per manufacturer's instructions.

  .5 Warranty forms are mailed and copies provided to Owner.

  .6 Systems are cleaned, flushed, strainers are cleaned.

  .7 Sample of Operating/Maintenance Manuals submitted. Arrange Operating and Maintenance Instruction Seminar and submit schedule for approval.

  .8 Equipment aligned by qualified millwright and certified report submitted.

  .9 Check operation of piping system and ensure components are solidly supported.

.10 Ensure electrical connections to mechanical equipment are complete.

.4 Prior to semi-final inspection, provide complete list of items which are not finished or deficient at the time of the semi-final inspection.

.5 Prior to final inspection provide declaration, in writing, that semi-final deficiencies and the following items have been completed:

.1 Equipment cleaned inside, outside and lubricated.

.2 Final calibration of controls completed and control system report submitted.

.6 When the design consultant is requested more than twice to inspect work prior to substantial or total performance, the Owner reserves the right to assess professional fees and other costs.

1.8 Shop Drawings

.1 Refer to Submittals, Section 01300.

.2 Shop drawing shall be scaled in standard English units.

.3 Submit materials and equipment by manufacturer, trade name and model number. Include copies of applicable brochure or catalogue material. Do not assume applicable catalogues are available in the Engineer's office. Maintenance and operating manuals are not suitable submittal material.

.4 Identify each sheet of printed submittal pages (using arrows, underlining or circling) to show applicable sizes, types, model numbers, ratings, capacities and options actually being proposed. Cross out non-applicable information. Note specified features such as special tank linings, pump seals, materials or painting.

.5 Include dimensional data for roughing in and installation, technical data sufficient to verify that equipment meets requirements of draiwngs and specifications. Include wiring, piping and service connection data, motor sizes complete with voltage ratings and schedules.

.6 Installed materials and equipment shall meet specified requirements regardless of whether or not shop drawings are reviewed by the Engineer.

.7 Maintain a complete set of reviewed and stamped shop drawings and product data on site.

1.9 Operating and Maintenance Manuals

.1 Refer Section 01700, Contract Close-Out.

.2 Provide services of qualified personnel to prepare documentation on the general operation and maintenance of equipment and systems provided. Complete and transmit documentation for review to Engineer 2 months prior to final inspection.

.3 Provide documentation agent with one set of plans, specifications, addenda and change orders for their use only.

.4 Provide 8 1/2" X 11" capacity, expanding spine catalogue binders, bound with heavy fabric, hot stamped lettering front and spine. Provide two copies to Owner, one copy to Engineer.

.5 Index binder according to the following system:

Tab - 1.0 Mechanical Systems:
Title page with clear plastic protection cover

Tab - 1.1 List of Mechanical Drawings

Tab - 1.2 Description of Systems:
Provide complete description of systems. (Include detailed system description, with individual components described, explanation of how components interface with others and to the complete system, location of thermostats, controllers or operating switches, summer or winter operating variances, and controller operating set points.)

Tab - 1.3 Operating Division:
Provide complete and detailed operation of major components. (Provide information on locations or components, how to energize switches and controls, how components interface with other components, operation of controls including operational sequence, operational changes for summer or winter operation, how to accomplish the changeover, complete troubleshooting sequence and safeguards to indicate if equipment goes off-line.)

Tab - 1.4 Maintenance and Lubrication Division:
Provide general maintenance and lubrication schedule for major components (to include daily, weekly, monthly, semi-annual and yearly checks and tasks. Explain how to execute maintenance tasks required for typical equipment such as bearings, drives, motors and filters. Compile this information for equipment separate from shop drawings.)

Tab - 1.5 List of Equipment Suppliers and Contractors:
Provide list of equipment suppliers and contractors, including address and telephone number. (Outline procedures for purchasing parts and equipment.)

Tab - Certification (2.0, 2.1, etc.):
Include copy of test data on hydrostatic or air tests performed on piping systems, equipment alignment certificates, water systems, copy of valve tag identification and pipe colour code.

Tab - Shop Drawings and Maintenance Bulletins (3.0, 3.1, etc.):
Provide material received in compliance with clause "Shop Drawings".

.6 The divider tabs shall be laminated mylar plastic and coloured according to Section. The colouring is as follows: Mechanical Systems - 1.0 - 1.5 Orange; Certification - 2.0 - 2.4 Green; Shop Drawings and Maintenance - 3.0 - 3.17 Yellow. Plastic tabs with typewritten card insertions will not be accepted.

.7 Submit documents to the Architect for approval prior to transmitting to the Owner.

1.10 Turnover Seminar

.1 At the completion of the project, organize and conduct a one day seminar to instruct the Owner and his representatives in the operation and general preventative maintenance of equipment and systems provided.

.2 At seminar, submit final copies of record drawings and operating and maintenance manuals to Owner.

1.11 Record Drawings

.1 Refer to Section 01700, Contract Close-Out.

.2 Maintain on site an extra set of drawings and specifications recording changes and variations daily. Transfer or arrange to transfer site changes to Engineer's original tracings. Provide the Owner with a set of mylar sepia transparencies marked "Record Drawings". Co-ordinate with Engineer.

.3 Record drawings shall identify locations of equipment, tagged valves and actual room names or numbers.

1.12 Identification

.1 Identify all piping and equipment with labels and direction of flow arrows. Apply labels at intervals closer than 20 ft in mechanical rooms. Legends and direction of flow arrows shall consist of adhesive backed labels, yellow colour with minimum 1" high black lettering.

.2 Provide 1" diameter brass tags or "Allflex" plastic tags with number stamped in black, secured to valve wheel with key chain, neat, typewritten directory giving valve number, valve service and location of valves. Frame one copy under glass for wall mounting in room designated.

.3 Tag automatic controls, instruments and relays and key to control schematic on which instruments are numbered in sequence.

.4 Identify electric starting switches and remote pushbutton stations with 1/4" high lettering on laminated plastic plates manufactured by Lamicoid.

1.13 Temporary Facilities

.1 Refer to Section 01500, Temporary Facilities and Controls.

1.14 Supervision

.1 Employ full time superintendant for the work until after total completion (and defects and deficiencies are rectified).

1.15 Equipment Protection and Clean-Up

.1 Protect equipment and materials on site, before, during and after installation until final acceptance. Leave factory protection in place; take precaution to prevent entry of foreign material into working parts of piping and duct systems.

.2 Protect equipment with polyethylene covers and crates.

.3 Operate, drain and flush bearings; change lubricant before final acceptance.

.4 Thoroughly clean piping and equipment from dirt, cuttings and other foreign substance.

.5 Protect bearings and shafts during installation. Grease shafts and sheaves; provide extended nipples for lubrication.

.6 Ensure existing equipment is carefully dismantled and not damaged or lost. (Do not re-use existing materials and equipment unless specifically indicated.)

1.16 Commissioning or Trial Usage

.1 Usage of mechanical equipment by the Owner before substantial completion shall not represent acceptance.

.2 Take responsibility for damage caused by defective materials or workmanship during such usage.

1.17 Electrical Motors

.1 Supply mechanical equipment complete with electrical motors.

.2 Provide motors to CEMA and CSA standards for hard, continuous service, designed to limit temperature rise to 40 deg. C for open housing and 50 deg. C for drip-proof housing. Operate at 1200 or 1800 r/min unless otherwise specified.

.3 Motors shall have ball or roller bearings with grease lubrication fittings.

.4 Refer to Division 16, Electrical for voltage, phase and frequency of electrically driven mechanical equipment. Co-ordinate electrical characteristics with all affected and related work.

.5 Provide a list of all motors and electrical connections associated with mechanical equipment, including voltages, power consumption, phases, etc., to the Engineer and Electrical Contractor within thirty (30) days after award of tender.

.6 Provide specified mechanical equipment with motors equal to Gould "E-Plus" energy efficient motors with minimum certified efficiencies as follows:

1.00 HP	82.5%
1.50 HP	83.0%
2.00 HP	84.5%

1.18 Drives, Guards & Accessories

.1 Provide coupling guard for every direct drive, constructed of 1/8", 3/4" diamond mesh wire screen welded to 1" steel angle frame. Prime coat at factory. Secure guards to driven machine, foundations or floors with steel angle supports and anchor bolts. Make provision for lubrication, use of tachometer, other maintenance and testing operations with guard in place.

.2 Provide oil level guages, grease cups, grease gun fitting for bearings. Where these are not easily accessible, extend to location as directed. Furnish grease gun fittings of uniform type.

1.19 Alternative Materials and Equipment

.1 Contract documents are based on materials and equipment specified. Approval by Engineer of equipment submitted by the mechanical trade as equal to that specified, does not relieve the mechanical trade of any responsibility.

.2 Equipment manufacturers listed in individual sections are approved for this project, subject to requirements of contract documents.

.3 Submit proposals to supply alternative materials or equipment, in writing, to the Architect at least 7 days prior to closing date of tender for mechanical work.

.4 Revisions required to adapt alternatives shall be included in such proposals.

TESTING SECTION 15042

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1. GENERAL

1.1 Work Included

.1 Steam distribution piping.

.2 Low pressure steam heating piping.

.3 Condensate piping.

.4 Hot water heating piping.

1.2 Related Work

.1 General Mechanical Provisions Section 15010

.2 Pipe Cleaning Section 15055

1.3 Quality Assurance

.1 Test equipment and material where specified or required by authority having jurisdiction to demonstrate its proper and safe operation.

.2 Test procedures shall be in accordance with applicable portions of ASME, ASHRAE, NFPA and other recognized test codes as far as field conditions permit.

.3 Provide notice to the Engineer before tests.

.4 Submittals

.1 Obtain certificates of approval and acceptance from authorities having jurisdiction and include in Operating and Maintenance Manuals.

.2 On completion of mechanical installation, provide certification of tests with detailed data as required. Itemize tests as to time performed and personnel responsible. Include copy of field data in Operating and Maintenance Manuals.

.5 Liability

.1 During tests, assume responsibility for damages in the event of injury to personnel, building or equipment and bear costs for liability, repairs and restoration.

2. PRODUCTS- not applicable.

3. EXECUTION

3.1 Pressure Tests

.1 Piping, fixtures or equipment shall not be concealed or covered until inspected and approved by the Engineer.

.2 Provide equipment, materials and labour for tests. Use test instruments from approved laboratory or manufacturer and furnish certificate showing degree of accuracy. Install permanent gauges and thermometers just prior to tests to avoid changes in calibration.

.3 Carry out hydraulic tests for 8 hours and maintain pressure. Where leakage occurs, repair and re-test.

.4 Hot Water Heating Piping: Test to 1-1/2 times max working pressure or 150 psi water pressure. Isolate new heating water piping from existing heating water piping for test.

.5 Low Pressure Steam and Condensate Above Ground Piping: Test to 100 psig hydrostatic pressure.

.6 Underground Piping: Hammer test under hydrostatic pressure of 250 psig or one and one half times the design pressure whichever is greater. Concealed pipe welds in prefabricated conduit fittings shall be factory tested the same as specified for field welds prior to assembly. Adhere to RIC-WIL instruction manual.

.7 Underground Conduit Containing Low Pressure Steam and Condensate Piping: Test all conduit field welds for air leaks before welding on connector bands and applying protective coatings. Check all welds with soap suds and re-weld if necessary until air tight at 15 psig before backfilling. Adhere to RIC-WIL instruction manual.

.8 Check systems during application of test pressure including visual check for leakage of water test medium, soap bubbler test for air test medium.

.9 During heating piping systems tests, check linear expansion at elbows, U-bends, expansion joints and offsets for proper clearance.

.10 Should tests indicate defective work or variance with specified requirements, make changes immediately to correct the defects. Correct leaks by re-making joints in screwed fittings, cutting out and re-welding welded joints.

.2 Performance Tests

.1 Conduct performance tests to demonstrate that equipment and systems meet specified requirments after mechanical installations are completed and pressure tested. Conduct tests as soon as conditions permit. Make changes, repairs, and adjustments required as tests may indicate prior to operating tests.

.2 Make operating tests for minimum of 5 days during heating season of first year of operation and at times when directed, for proper setting of controls under peak load conditions.

.3 Conduct final operating tests in presence of the Owner. Vary loads to illustrate start-up and shut-down sequence and simulate emergency conditions for safety shut-downs, with automatic and manual reset. Make final adjustments to suit exact building conditions.

.4 Provide services of one job mechanic, ladders, tools and associated equipment required to assist the Owner in final tests.

.5 Lubricate bearings, adjust and/or replace and set direct drives for proper alignment and tension.

.6 Calibrate and adjust temperature controller, thermometers and pressure guages. Control valves shall be operated freely.

.7 Operate and test motors for correct wiring and sequences. Check overload heaters in motor starters.

.8 Fasten loose and rattling pieces of equipment to ensure quiet operation.

PIPE CLEANING

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1. GENERAL

1.1 Work Included

.1 Cleaning of heating water system addition to P.W. Kaeser.

.2 Cleaning of steam and condensate piping up to point of tie in to existing systems (excluding pumps).

1.2 Quality Assurance

.1 Notify the Engineer prior to commencing cleaning operation.

1.3 Submittals

.1 Provide written report containing log and procedure of system cleaning giving times, dates, problems encountered and condition of water.

2. PRODUCTS

2.1 Materials

.1 System Cleaner: Alkaline compound which in solution removes grease and petroleum products (e.g. tri-sodium phosphate).

3. EXECUTION

3.1 Systems Cleaning

.1 Prevent debris, dirt and other foreign material from entering piping system during construction.

.2 Provide drain connections to completely drain systems in one hour.

.3 Flush open systems for one hour minimum with clean water. Drain completely and refill.

.4 Inspect, clean of sludge and flush low points with clean water after cleaning process is completed. Include disassembly of components as required.

SECTION 15060

PIPE AND PIPE FITTINGS AND VALVES

1. GENERAL

1.1 Work Included

.1 Steam and condensate system piping.
.2 Hot water heating system piping.

1.2 Related Work

.1	Submittals	Section 01300
.2	Trenching, Excavation, Backfilling and Grading	Section 02220
.3	Testing	Section 15042
.4	Supports, Anchors and Seals	Section 15090
.5	Condensate Pumps & Receivers	Section 15140
.6	Heat Exchangers	Section 15730
.7	Controls	Section 15900

1.3 Welding

.1 Welding materials and labour shall conform to ASME Code and the Local Board of Labour Regulations.

.2 Use welders fully qualified and licensed by Local Authorities.

1.4 Quality Assurance

.1 Steam and Condensate Piping: ANSI B31.1 Power Piping.

.2 Underground Conduit System: Stress limits for expansion as indicated by ASME Code for Pressure Piping, District Heating Section.

.3 Hot Water Heating: ANSI B31.1 Power Piping.

.4 Underground distribution system manufacturer's Field Installation Instructor, who is technically qualified to determine whether or not the installation is being made in accordance with the manufacturer's recommendation shall be present during critical periods of installation and test of the system. On completion of the installation, the contractor shall deliver to the owner a certificate from the manufacturer stating that the installation has been made in accordance with the manufacturer's recommendations.

1.5 Submittals

.1 Submit shop drawings of Underground Piping Systems in accordance with Section 01300.

.2 Submit copies of valve "ordering schedule" for approval before ordering valves.

.3 Submit detailed shop drawings which clearly indicate make, model, location, type, size and pressure rating.

1.6 Manufacturer

.1 Provide valves of same manufacturer throughout where possible.

.2 Provide valves with manufacturer's name and pressure rating clearly marked on outside of body.

2. PRODUCTS

2.1 Underground Distribution Conduit System

.1 System: Ricwil Galva-Gard or approved alternate, or prefabricated carbon steel piping, preinsulated and contained in a galvanized steel conduit.

.2 Conduit: 10 gauge smoothwall hot dipped galvanized steel having all outside surfaces of the conduit machine-coated with high melting point asphalt to a minimum thickness of 3/16" with an interposed layer of fiberglass screen plus one final outer wrap of asphalt impregnated, fiberglass reinforced, pipe line felt applied spirally under tension.

Conduit closures shall be furnished with the conduit at a ratio of one closure for each fabricated item or length. Closures shall consist of 10 gauge steel suitably rust-proofed and in cylindrica form with a single horizontal split and shall be field welded ove adjacent units. After test all exposed closures shall be covered in the field with Rip-Coat Coating and Rip-Coat Blanket. All materials and insulation required for complete field closure shal be furnished with the conduit.

Piping shall be suitably spaced and supported in conduit by specially designed full round insulating support-guides and shall permit the pipe to expand and/or contract freely without stress o wear on the pipe or insulation as well as provide for drainage an free air circulation. (Both low pressure steam and pumped condensate are to be contained in the same conduit.)

.3 Pipe Material: ASTM A-53 ERW.

.4 Assembly on site: Arcwelding.

.5 Anchors: Prefabricated plate anchors shall be furnished and installed where shown on plans and shall consist of a steel plate welded to pipe and conduit. The steel plate shall be 3/8" thick for 6 5/8" to 10 3/4" conduit, 1/2" thick for 12" to 22" conduit and 3/4" thick for conduit over 22".

A concrete block shall be cast over the plate and conduit and shall be large enough for firm anchorage into undisturbed trench sidewalls and/or bottom. The concrete block to be at least 30" in length and extend a minimum of 9" beyond the top and bottom of anchor plate.

Anchor locatins are shown on the site plan M-1. Those anchors located near the Wood Chip Boiler Plant and the school Mechanical Rooms shall be located 5 ft. out from building walls.

.6 Expansion Allowance: Anchor points shown on the drawings have been tentatively located so as to permit anchor to anchor expansion. Conduit elbows shall be suitably sized to allow movement of piping in the conduit. Supplier to determine exact location and number of anchor points to ensure adequate expansion allowance.

Prefabricated ells, shall be furnished and installed where shown on plans and shall consist of pipe, insulation, and conduit conforming to the same specification as specified for straight runs.

.7 End Seals and Glands: Terminal ends of conduits inside building walls shall be equipped with end seals consisting of a steel bulk head plate welded to the pipe and conduit. Where there is no anchor within five feet of a terminal end, conduits shall be equipped with gland seals consisting of a packed stuffing box and gland follower mounted on a steel plate welded to end of conduit. End seals or gland seals shall be equipped with drain and vent openings located diametrically opposite on the vertical center line of the mounting plate and shall be shipped to the job site with plugs in place. Terminate all conduits 2" beyond the inside face of building walls to protect any exposed piping insulation from damp-wall condensation.

.8 Leak Plates: Conduits shall be equipped with leak plates where they pass through building walls, to provide an effective moisture barrier. Leak plates shall consist of a steel plate flange 4" larger in outside diameter than the conduit welded to the conduit only and located in the wall approximately 6" from the end of the conduit. Grout conduits and leak plates in concrete walls.

Pipe Insulation: All pipes in conduit shall be insulated as specified in Section 15250.

2.2 Above Ground Piping

.1 See 3.6 Piping Schedule.

3. EXECUTION

3.1 Preparation

.1 Ream pipes and tubes.

.2 Remove scale and dirt, inside and outside, before assembly.

.3 Remove welding slag or other foreign material from piping.

.4 Design complete Underground Distribution Conduit System, including all anchors, expansion allowances, etc. Submit shop drawings to Engineer for approval before commencing construction.

3.2 Connection

.1 Screwed joints for steel piping up to and including 1 1/2". Weld piping 2 1/2" and larger, including branch connections. Screw or weld 2" piping.

.2 Make screwed joints with full cut standard taper pipe threads with red lead and linseed oil or other approved non-toxic joint compound applied to male threads only.

.3 Use tees at full size branch connections.

.4 Make connections to equipment and branch mains with unions for sizes up to and including 2".

.5 Provide non-conducting type connetions wherever jointing dissimilar metals in open systems. Brass adapters and valves are acceptable.

.6 Provide unions on both sides of all steam traps.

3.3 Routes and Grades

.1 Route piping in orderly manner and maintain proper grades.

.2 Install to conserve headroom and interfere as little as possible with use of space.

.3 Run exposed piping parallel to walls.

.4 Group piping wherever practical at common elevations.

.5 On closed water systems, equip low points with 3/4" drain valves and hose nipples. Provide, at high points, collecting chambers and high capacity float operated automatic air vents.

.6 Slope hot water heating piping 0.2% and arrange to drain at low points.

.7 Slope underground piping in direction of flow at 0.20% (i.e. from Wood Chip Boiler to the Mechanical Rooms in the three schools.

.8 Within buildings slope steam piping 0.42% in direction of flow and condensate return piping 0.63%. Provide drip trap assembly at low points and points where condensate may back up in front of control valves. Run condensate lines from traps to nearest condensate receiver. Where condensate lines form a trap, provide vent loop over the trapped section.

.9 Make reductions in water and steam pipes with eccentric reducing fittings installed to provide drainage and venting.

.10 Pipe P.C. drain connections to nearest floow drains.

3.4 Installation

.1 Install piping to allow for expansion and contraction without unduly stressing pipe or equipment connected.

.2 Provide clearance for proper installation of insulation and for access to valves, air vents, drains and unions.

.3 All field welded joints of underground piping shall be welded by competent mechanics and hammer tested under hydrostatic pressure of 250 psig or one and one half times the design pressure, whichever is greater. Concealed pipe welds in prefabricated conduit fittings shall be factory tested and same as specified for field welds prior to assembly.

.4 All field welds at conduit closures shall be tested for leaks before welding on connector bands and applying finish coatings. During test all field welds shall be checked with soap suds and rewelded if necessary until airtight at 15 psig. The contractor shall furnish all necessary equipment and labour to perform the air test, including air compressor, gauges, conduit caps, temporary pipe and connections, etc. and complete the test to the satisfaction of the Engineer.

.5 Use spreader bars of the type recommended by Ric Wil to pick up and lay pre-assembled piping sections in trenches.

.6 During construction protect insulation in underground piping system from exposure to water.

.7 Install valves with stems upright or horizontal, not inverted.

.8 Install gate valves for shut-off and isolating service; to isolate equipment, parts of systems or vertical risers.

.9 Install globe or angle valves for throttling services and control device or meter bypass.

.10 Provide drain valves at main shut-off valves, low points of piping and apparatus.

3.5 Schedule For Underground Piping

Pipe Run	Low Press Steam		Condensate	
To	Size	Sch	Size	Sch
Breynat Hall	4"	40	2"	80
J.B. Tyrrell	4"	40	2"	80
P.W. Kaeser	3"	40	1 1/2"	80

3.6 Schedules for Above Ground Piping

.1

Service	Low Pressure Steam
Operating Pressure	15 psig to 20 psig
Operating Temperature	250 deg. F.
Nominal Rating	150# ANSI
Hydrostatic Test	See Section 15042
Fabriction Standards	ANSI B31.1

Description	Size	Code
1. Pipe		
ASTM, A-53 ERW		L.P.S.
Schedule 80	2" and under	
Schedule 40	2 1/2" - 6"	
2. Joints		
Welded throughout, Flanged only as indicated. Small connections screwed.		

Description	Size	Code
3. Valves		
Gate: screwed, 150 psi bronze body, solid wedge disc, rising stem. Crane 431	1/2" -2"	V1
Gate: flanged, 125 psi iron body, solid wedge disc. Crane 465	3" - 6"	V2
Globe: screwed, 150 psi bronze body, No. 1 composition disc. Crane No. 7	1/2" -2"	V3
Globe: flanged, 125 psi iron body, No. 1 composition disc. Crane 341 1/4	3" - 4"	V4
Check: screwed, 150 psi bronze body, swing check. Crane 137	1/2" - 2"	V5
Check: flanged, 125 psi iron body, swing check, iron trim. Crane 373 1/2	3" - 4"	V6
4. Flanges		
150 psi C.S., WNRF or WNFF, ASTM A-181 Gr. 1 (use F.F. flanges against C.I. flanges)	3" - 4"	

Description	Size	Code
5. Fittings		
Buttweld SMLS, CS, ASTM A-234 Gr. B. ASA B16.9. Wall thickness as per pipe.	2" and over	
Malleable iron 150 psi banded.	2" and under	
6. Bolting		
Bolt Alloy Steel ASTM, A-193 Gr. B7, Hex nuts, alloy steel.	All sizes	
ASTM, A-194, Gr.2H	All sizes	
7. Gaskets		
ASA B16.5 150 psi		
8. Weld-O-Lets		
FS ASTM, A-105 II	All sizes	
9. Strainers		
Screwed, bronze Y pattern with S.S. screen and blow off valve	2" and under	S1
10. Steam Traps		
Armstrong No. 15-B6 F & T trap at 2400 lbs/hr condensate with 1/2" orifice and 2 psi differential	1 1/2" pipe conn's	T1

Description	Size	Code
10. Steam Traps (Cont'd)		
Armstrong No. 800 CI. Inverted bucket trap, rated at 600 lbs/hr condensate with 3/16" orifice and 15 psi differential	3/4" pipe conn's	T2
11. Air Vents		
Armstrong Model TV-2. Thermostatic Air/Vent.	1/2" pipe conn's	AV1
12. Vacuum Breaker		
Use Check Valve V5	1/2" - 2"	VB

.2	Service	Condensate
	Operating Pressure	15 psig
	Operating Temperature	250 deg. F.
	Nominal Rating	150# ANSI
	Hydrostatic Test	See Section 15042
	Fabrication Standards	ANSI B31.1

Description	Size	Code
1. Pipe		P.C., C.
ASTM, A-53 ERW Schedule 80	2" and under	
2. Joints		
Welded or screwed		
3. Valves		
Same as LPS		
4. Flanges		
Same as LPS		

Description	Size	Code
5. Fittings		
Same as LPS		
6. Bolting		
Same as LPS		
7. Gaskets		
Same as LPS		
8. Weld-O-Lets		
Same as LPS		
9. Strainers		
Same as LPS		
10. Unions		
150 psi malleable iron, bronze to iron ground joint for C.S. piping, all bronze for copper piping.		

.3	Service	Hot Water Heating
	Operating Pressure	30 psig
	Operating Temperature	200 deg. F.
	Nominal Rating	150# ANSI
	Hydrostatic Test	See Section 15042
	Fabrication Standards	ANSI B31.1

Description	Size	Code
1. Pipe		HWH
Same as LPS		
2. Joints		
Same as LPS		

Description	Size	Code
3. Valves		
Same as LPS		
4. Flanges		
Same as LPS		
5. Fittings		
Same as LPS		
6. Bolting		
Same as LPS		
7. Gaskets		
Same as LPS		
8. Air Vents		
Armstrong No. 21-AR CI single lever vent, foat type with 5/64" orifice.	3/4" pipe conn's	AV2

SUPPORTS, ANCHORS AND SEALS

---

1. GENERAL

1.1 Work Included

- .1 Pipe hangers and supports.
- .2 Equipment bases

1.2 Related Work

- .1 Pipe and Pipe Fittings Section 15060

1.3 Quality Assurance

- .1 Pipe Supports: ANSI B31.1, Power Piping.

1.4 General Requirements

- .1 Provide hangers and supports to secure equipment in place, prevent vibration, maintain grade, provide for expansion and contraction and to accomodate insulation; provide insulation protection saddles.
- .2 Install supports of strength and rigidity to suit loading without unduly stressing building. Locate adjacent to equipment to prevent undue stresses in piping and equipment.
- .3 Select hangers and supports for the service and in accordance with the manufacturer's recommended maximum loading. Hangers shall have a safety factor of 5 to 1.
- .4 Fasten hangers and supports to building steel or inserts in concrete construction.
- .5 Use of existing piping or equipment for hangers supports is not permitted.
- .6 Use of perforated band iron, wire or chain as hangers is not permitted.
- .7 Support from top cord of open web steel joists or as approved by Engineer.

1.5 Approvals

- .1 Obtain approval prior to drilling for inserts and supports for piping systems.

.2 Obtain approval prior to using percussion type fastenings.

2. PRODUCTS

2.1 Inserts

.1 Inserts shall be expansion bolts of steel shell and expander plug.

2.2 Pipe Hangers and Supports

.1 Hangers - Pipe Sizes 1/2" to 1 1/2": Adjustable wrought steel ring.

.2 Hangers - Pipe Sizes 2" tp 4" and Cold Pipe Sizes 6" and Over: Adjustable wrought steel clevis.

.3 Wall Support - Pipe Sizes 3": Cast iron hook.

.4 Wall Support - Pipe Sizes 4" and Over: Welded steel bracket and wrought steel clamp, adjustable steel yoke and cast iron roll for hot pipe.

.5 Vertical Support - Steel riser clamp.

.6 Floor Support - Pipe Sizes to 4" and All Cold Pipe Sizes: Cast iron adjustable pipe saddle, locknut nipple, floor flange and concrete pier to steel support.

.7 Design hangers so they cannot become disengaged by movements of supported pipe.

2.3 Hanger Rods

.1 Provide steel hanger rods, threaded both ends, threaded one end, or continuous threaded.

3. EXECUTION

3.1 Inserts

.1 Use inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams wherever practicable.

.2 Expansion inserts must have a load rating to give a safety factor of 5 to 1.

.3 Size inserts to suit threaded hanger rods.

3.2 Pipe Hangers and Supports

.1 Support horizontal steel and copper piping as follows:

Nominal Pipe Size in.	Distance Between Supports ft.	Hanger Rod Diameter in.
1/2"	6	3/8"
3/4" to 1 1/2"	8	3/8"
2" to 2 1/2"	12	3/8"
3" to 4"	14	5/8"

.2 Install hangers to provide minimum 1/2" clear space between finished covering and adjacent work.

.3 Place a hanger within 12" of each horizontal elbow.

.4 Use hangers which are vertically adjustable 1 1/2" minimum after piping is erected.

3.3 Equipment Bases and Supports

.1 Provide for major equipment reinforced concrete housekeeping bases poured directly on structural floor slab 4" thick minimum, extended 4" minimum beyond machinery bedplates. Provide templates, anchor bolts and accessories required for mounting and anchoring equipment.

.2 Construct supports of structural steel members or steel pipe and fittings. Brace and fasten with flanges bolted to structure.

CONDENSATE PUMPS & RECEIVERS SECTION 15140

---

1. GENERAL

1.1 Work Included

.1 All condensate pumps including those integral with a condensate receiver.

.2 Pump controls where self-contained.

1.2 Related Work

.1	Pipe, Pipe Fittings & Valves	Section 15060
.2	Piping and Equipment Insulation	Section 15250

1.3 Submittals

.1 Submit with shop drawings certified pump curves showing pump performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable.

1.4 Quality Assurance

.1 Pumps shall be aligned by qualified millwright and alignment certified.

.2 Ensure pumps operate at specified system fluid temperatures without vapour binding and cavitation, are non-overloading in parallel of individual operation, operate within 25% of midpoint of published maximum efficiency curve.

1.5 Acceptable Manufacturers

.1 Manufacturers of base mounted condensate pumps are approved in principle but subject to requirements of drawings and specifications are:

Darling Duro, Leitch, Armstrong, Bell & Gossett.

.2 Manufacturers of condensate pump & receiver units are approved in principle but subject to requirements of drawings and specifications are:

Darling Duro

2. PRODUCTS

2.1 General

.1 Statically and dynamically balance rotating parts.

.2 Construction shall permit complete servicing without breaking piping or motor connections.

.3 Pumps shall operate at 1750 r/min unless specified otherwise.

.4 Pump connections shall be flanged.

.5 Pumps shall be suitable for handling steam condensate at 250 degrees F.

2.2 Base Mounted Condensate Pumps

.1 Type: Centrifugal, single stage, direct connected.

.2 Casing: Cast iron, split volute, single or double suction, rated for greater of 125 psi or 1.25 times actual working discharge pressure, renewable bronze wearing rings, flanged suction and discharge, seal flushing connections.

.3 Impeller: Bronze, fully enclosed, keyed to shaft.

.4 Shaft: High grade alloy steel with copper, bronze or stainless steel shaft sleeves.

.5 Bearings: Oil lubricated roller or ball bearings with oil reservoirs. Provide oil seal and integral dirt and water seal at each end of reservoir.

.6 Drive: Flexible coupling with coupling guard.

.7 Baseplate: High grade heat treated cast iron or reinforced heavy steel with integral drain rim. Grout base.

2.3 Condensate Pump & Receiver Package

.1 Type: Single Vertical Centrifugal pump mounted on a 40 U.S. gallon duplex steel receiver with coverplate over opening for future second pump, heavy duty copper float, float switch & float gear, factory assembly and prewired.

3. EXECUTION

3.1 Installation

.1 Provide drains for bases and stuffing boxes piped to and discharging into floor drains.

.2 Provide air cock and drain connection on horizontal pump casings.

.3 Support piping adjacent to pump such that no weight is carried on pump casings.

.4 Check and align base mounted pumps prior to start-up.

3.2 Performance

.1 Refer to Pump Schedule.

3.3 Pump Schedule

Number: P1 & P2
Location: J.B. Tyrrell Elementary School & Breynat Hall Residence.
Service: 250 deg.F steam condensate.
Manufacturer: Darling Duro.
Model: 1" D.W. horizontal base mounted.
Capacity: 15 USGPM, 15 psi (35 ft. TDH)
Motor: 1 HP.
Electrical: 208V, 1 phase, 60 Hz.
1.15 S.F.

Number: P3
Location: P.W. Kaeser High School.
Service: 250 deg.F steam condensate.
Manufacturer: Darling Duro.
Model: Little Unicon Condensate Pump & Receiver.
Receiver Capacity: 40 U.S. Gallons.
Capacity: 9 USGPM, 15 psi. (35 ft. TDH)
Motor: 1/3 HP
Electrical: 1.15 S.F.

METERS AND GAUGES

---

1. GENERAL

1.1 Work Included

.1 Provide all required meters, gauges and thermometers.

1.2 Submittals

.1 Submit shop drawings of meters, gauges, thermometers, metering runs and orifice flanges, & orifice plates.

2. PRODUCTS

2.1 Positive Displacement Meters

.1 1 inch Neptune Type SM Green Seal industrial meter, non-resettable totalizer with Model 157 register.

Service: 250 Deg. F. Steam Condensate.

Registration: in U.S. gallons (seven digit register).

No. Required	Location	Max. Flow	Size
1	Wood Chip Boiler Bldg.	40 USGPM	1"
1	Breynat Hall	15 USGPM	3/4"
1	J.B. Tyrrell School	15 USGPM	3/4"
1	P.W. Kaeser School	9 USGPM	3/4"

2.2 Metering Run (Boiler Plant)

.1 6" dia., sch. 40 orifice flange standard metering tube with 300# ANSI weldneck forged steel orifice flanges with 1/2" N.P.T. taps complete with bolting, gaskets, orifice plate. Provide calculation sheets for approval.

.2 Concentric thin plate, sharp edge 304 stainless steel paddle type orifice plant c/w weep hole.

Service Conditions

Upstream pressure: 15 psig saturated steam.
Maximum Flow: 5500 lbs/hr.
Differential Range: 30 in H20.

.1 Accuracy shall be plus or minus 1/4% of full scale.

.2 Permanent pressure loss shall not exceed 25% of pressure differential.

.3 Metering run shall be complete with an identification tag, conversion chart, and shut off valves.

2.3 Orifice Plates (Building Mechanical Rooms)

.1 Concentric thin plate sharp edge 304 S.S. paddle type orifice plate c/w weep hole.

.2 300# ANSI weldneck forged steel flanges with 1/2" NPT taps c/w bolting gaskets and shut off valves.

.3 Mount orifice plate and flanges in straight run of pipe as dictated by good metering practice. Location to be approved by Engineer.

.4 Size orifice as follows, provide calculation sheets for approval.

Service Conditions

Upstream pressure:	15 psig saturated steam.
Maxmimum Flor:	Breynat - 2200 lb/hr.
	J.B.T. - 2200 lb/hr.
	P.W.K. - 1100 lb/hr.
Differential Range:	30 in H20

2.4 Pressure Gauges -PI's

.1 Gauges shall be 4 1/2" diameter 1% accuracy cst aluminum case, aluminum ring, tube, brass movement, front recalibrator, and glass window.

.2 Dials shall read psig.

.3 For gauges on liquid service provide a bronze pulsation damper and needle valve.

.4 For steam service provide a straight pigtail syphon and needle valve.

.5 Ranges as required for service, submit to Engineer for approval.

2.5 Thermometers - TI's

.1 Thermometers shall be 3" dial in drawn steel case, bimetallic helix actuated Fahrenheit scale. All to be c/w brass thermometer wells.

.2 Ranges as required for service, submit to Engineer for approval.

2.6 Thermometer Wells -TW's

.1 Wells shall be machine from brass bar stock and complete with cap and chain and 3/4" NPT thread.

3. EXECUTION

3.1 Installation

.1 Provide pressure gauges and thermometers where shown on drawings.

.2 Enlarge pipes smaller than 2 1/2" for installation of thermometer wells.

.3 Provide orifice in series with positive displacement flowmeters in buildings to limit flow to maximum specified.

PIPING AND EQUIPMENT INSULATION

---

1. GENERAL

1.1 Work Included

.1 Piping insulation.
.2 Equipment insulation.
.3 Adhesives, tie wires, tapes.
.4 Recovering.

1.2 Quality Assurance

.1 Insulation shall be installed by skilled workmen regularly engaged in this type of work.

1.3 Submittals

.1 Submit shop drawings which indicate complete material data, a list of materials proposed for this project and indicate thickness of material for individual services.

.2 Submit samples of proposed insulating materials.

1.4 Site Conditions

.1 Perform work at ambient and equipment temperatures as recommended by the adhesive manufacture. Make good separation of joints or cracking of insulation due to thermal movement or poor workmanship.

2. PRODUCTS

2.1 Acceptable Manufacturers

.1 Fiberglas, Johns-Manville, Fiberglass Canada

2.2 Materials

.1 Hot Piping Above Ground: Fine fibrous glass insulation with factory applied general purpose jacket, moulded to conform to piping, "K" vaue at 250 degrees F maximum 0.30 BTU/HrSq.Ft./In/Deg. F.

.2 Hot Piping, Underground: Ricwil sectional glass insulation with an open mesh fiber glass cloth jacket.

.3 Hot Equipment: Rigid fibrous glass insulation, "K" value at 250 degrees F maximum 0.30 BTU/Hr/Sq/Ft./Deg. F.

2.3 Accessories

.1 Adhesives, Insulating, Coatings, Sealers and Recovering Jackets: Composite fire and smoke hazard ratings shall not exceed 25 for flame spread and 50 for smoke developed. Adhesives, coatings, and sealers shall be waterproof.

.2 Recoverng Jackets: ULC listed "Thermo Canvas", treated cotton fabric manufactured by S. Fattal Canvas Inc.

3. EXECUTION

3.1 Preparation

.1 Do not install covering before piping and equipment has been tested and approved.

.2 Ensure surface and insulation is clean and dry prior and during installation.

3.2 Installation

.1 Ensure insulation is continuous through inside wals. Pack around pipes with fireproof self-supporting insulation material, properly sealed.

.2 Insulate fitting and valves. Do not insulate unions, flanges, flexible connections and expansion joints on Hot Piping Systems. Terminate insulation neatly with plastic material trowelled on a bevel.

.3 Finish insultion neatly at hangers, supports and other protrusions.

.4 Provide removeable sections over eqipment and fittings requiring access.

.5 Provide recovering jackets on exposed insulation throughout including equipment rooms. Insulation located in crawl spaces, pipe shafts and suspended ceiling spaces is not considered exposed. Use pre-sized paper under recovering at uneven insulated surfaces.

.6 Hot Piping: Cover fittings and valves with equivalent thickness of insulation material. For exposed fittings and valves, apply hydraulic setting cement paste over insulating material before applying recovering.

3.3 Insulation Requirements and Thickness Schedule

	Piping To Be Insulated	Pipe Sizes	Insulation Thickness
.1	Hot Water Heating	All sizes	1"
.2	Low Pressure Steam and Condensate (Above Ground)	All sizes	1"
.3	Low Pressure Steam (Underground)	All sizes	1"
.4	Pumped Condensate (Underground)	All sizes	1"

	Equipment to be Insulated	Insulation Thickness
.1	Heat Exchangers	2"
.2	Condensate Tanks	2"

HEAT EXCHANGERS

---

1. GENERAL

1.1 Work Included

.1 Heat exchanger.
.2 Instrumentation.
.3 Insulation.
.4 Piping connections & valves.
.5 Steel supports.

1.2 Related Work

.1	Meters, Gauges and Thermometers	Section 15170
.2	Controls	Section 15900

1.3 Quality Assurance

.1 Design and construction shall meet requirements of ASME Code for Unfired Pressure Vessels and Provincial Codes.

1.4 Acceptable Manufacturers

.1 Manufacturers whose products are approved in principle but not subject to requirements of drawings and specifications are:

Darling Duro, Leitch, Taco, Alco, Arstrong, Bell & Gossett.

1.5 Submittals

.1 Shop drawings shall include dimensions, locations and size of tappings, and performance data to compare with specification.

2. PRODUCTS

2.1 General

.1 Units shall be "U" tube type with 3/4" minimum seamless copper tubes suitable for 150 psig working pressure.

.2 Heads shall be cast iron or steel, with steel or bronze tube sheets, threaded or flanges for piping connections.

.3 Water chamber and tube bundle shall be removable for inspection and cleaning.

.4 Prime coat exterior of units.

2.2 Shell and Tube Heat Exchanger

.1 Shell shall be steel, with threaded or flanged piping connections and necessary tappings.

.2 Two pass arrangement.

.3 Provide steel saddle supports and attaching U-bolts.

.4 Design units for heating fluid in shell and heated fluid in tubes.

2.3 Steam to Water Heat Exchanger Trim

.1 Provide for temperature controller sensor at water outlet.

.2 Provide thermometers in water inlet and outlet.

3. EXECUTION

3.1 Installation

.1 Ensure installation permits removal of tubes without disturbing installed equipment or piping.

.2 Refer to drawings for details of installation and piping connections.

.3 Support exchanger on a welded angle steel frame mounted on the floor. Submit shop drawing to Engineer for approval.

3.2 Heat Exchanger Schedule

Identification:	Heat Exchanger
Location:	Mechanical Room: P.W. Kaeser High School
Service:	Hot Water Heating
Manufacturer:	Darling Duro or Approved Alternate
Model:	Type "MR"
Heating Media:	
Type:	2 psig Saturated Steam
Entering degrees F:	250
Flow Lbs/Hr.:	1100
Working Pressure psig:	150
Heated Media:	
Type:	Hot Water
Entering degrees F:	180
Leaving degrees F:	200
Flow USGPM:	110 USGPM
Working Pressure psig:	150

Heated Media:

Type:	Hot Water
Entering degress F.:	180
Leaving degrees F.:	200
Flow USGPM:	110 USGPM
Working Pressure psig:	150

CONTROLS

---

1. GENERAL

1.1 Work Included

- .1 Complete system of automatic controls.
- .2 Electric control system.
- .3 Control devices, components, wiring and material.
- .4 Metering system
- .5 Instructions to Owners.

1.2 Related Work

.1	Testing	Section 15042
.2	Electrical Interface	Division 16

1.3 Quality Assurance

.1 Provide a complete system of automatic controls for mechanical systems by firms employing certified journeymen who specialize in this type of work and have proof of completing five (5) projects of similar size and complexity.

.2 The equipment shall be of one manufacturer and installed by certified mechanics and electricians regularly employed by the manufacturer.

1.4 Submittals

.1 Submit shop drawings in accordance with Section 15010.

.2 Include complete operating data, component setpoints, system drawings, wiring diagrams, written detailed sequences of operation and engineering data on each control system component. Include sizing as requested.

.3 Label components on drawings and identify as to function.

.4 Provide wiring numbers for all wiring. Indicate numbers on shop drawings.

1.5 Owner Orientation

.1 At completion of installation, provide minimum of 1 day instruction period for operating personnel.

1.6 Warranty

.1 Include warranty provisions identified in contract.

.2 Adjust control system as required. Submit written reports to the Engineer.

2. PRODUCTS

2.1 General

.1 Provide systems consisting of temperature controller, control valve, temperature switches, level switches and steam metering devices and other apparatus required to operate mechanical system and to perform functions specified.

.2 Provide materials and field work necessary to connect control components.

.3 Provide electric devices as part of this work.

.4 Provide wiring numbers on all wiring. Numbers to match numbers indicated on the shop drawings.

2.2 Hot Water Heating Controls (At P.W. Kaeser)

.1 Temperature Controller TC-1

Honeywell Electric T-491A Proportional Temperature Controller with

- Adjustable setpoint range of 160 to 260 deg. F.
- Standard response.
- Sensing bulb with SS immersion well assembly.

.2 Control Valve

1 1/2" dia. Honeywell model V5011B Equal Perentage Valve 2-Way Valve

- Bronze body
- Fail closed
- SS plug
- Teflon cone packing
- Max. flow rate 1100 lb/hr.
- Inlet pressure 10 psig

c/w Honeywell M-945 Modutrol Motor Operator

- 24V
- Modulating Spring Return Motor
- 120V/24V transformer
- Honeywell Q618 Modutrol Motor/Valve Linkage

2.3 Steam Flow Metering (At Wood Chip Boiler Plant)

.1 Flow Transmitters FT-H & FT-L

ITT Barton Model 6001 Differential Pressure Transmitter with

- 316 SS flanges
- 316 SS diaphragm
- 4-20 MA output
- Silicon oil filled sensing unit suitable for 212 deg. F.
- 1/2" NPT process connections
- Universal mounting bracket
- Standard certification

High Range Transmitter FT-H

Differential Range	0-5/50" W.C.
Calibration	4 MA = 3" W.C. 20 MA = 30" W.C.

Low Range Transmitter FT-L

Differential Range	0-.4/4" W.C.
Calibration	4 MA = 0" W.C. 20 MA = 3.33" W.C.

.2 Provide C.S.Condensate Pots and C.S. Anderson Greenwood M1VHC-4 3-way valve manifold, tubing - 304 SS, fittings - 304 SS Swagelok, valves - 1/2" H7 C.S. Anderson Greenwood.

.3 Pressure Transmitter PT

ITT Barton Model 6005 Gage Pressure Transmitter

- Pressure range 0-6/60 psi
- 316 SS flanges
- 316 SS diaphragm
- 4-20 MA output
- Sensing unit cell with silicone oil fill suitable for 212 deg. F.
- 1/2" NPT process connections
- Universal mounting bracket
- Standard certification
- Calibration 4 MA = 0 psi
  20 MA = 20 psi
- Zero suppression to suit mounting elevation

.4 Flow Computer Flow Totalizer FY, FQI, FI

ITT 38IC-1 Microprocessor based flow totalizer with weatherproof panel

- To input 4-20 MA signals for flow and static pressure
- Automatically switch between high and low flow ranges (Dual range orifice program)
- Do pressure compensated mass flow calculations
- Indicate steam flow in lbs/hr.
- Indicate totalized steam flow in lbs.
- Output of 4-20 MA linear flow signal (to recorder)

.5 Recorder

Honeywell Model AR11BMS1020 Circular Chart 2 Pen Recorder

- 4-20 MA inputs
- Scale range 0-100 (each pen)
- 7 day chart
- With following chart factor tags:
  Steam Flow
  X 55 lb/hr.
  Steam Press
  X .20 psig

2.4 High Level Switches LSH-1 & 2

McDonnell & Miller FLoat Actuated Pump Controller

- For condensate pump start/stop
- Steam condensate service
- 240 VAC motor duty

2.5 Low Temperature Switches

Honeywell Model T675A Tradeline Temperature Controller with

- Fixed differential at 1 deg. F.
- Operating temperature range 0 to 100 deg. F.
- 20 Ft. SS capilliary
- 3/4" - 14 NPT immersion well
- SS thermowell and compression fitting for thermowell

2.6 Freeze Alert Alarms TAL-1,2,3,4,5 & 6

Edwards AdaptaBeacon N050-R Flashing Light

- 120 VAC model
- Weatherproof
- Red lens

2.7 Instrument Panel

.1 Panels shall be general purpose utility enclosure having an enamel finished face panel and CSA approved for line voltage applications.

.2 Mount panels adjacent to associated equipment on vibration free walls or free standing angle iron supports. Provide engraved plastic nameplates for instruments and controls inside cabinet and engraved lamicoid nameplates on cabinet face.

.3 Number code all wiring.

3. EXECUTION

3.1 Installation

.1 Mount 6 temperature switches in weatherproof boxes outside building walls. Shield capilliary in PVC conduit from box down to 12" below grade. Run capilliary along top of Ricwil conduit and install temperature element in the wall as shown on drawings.

.2 Mount temperature control TC-1 5 feet above floor and connect to temperature control valve TCV-1.

.3 Mount steam metering flow computer and 2 pen recorder in a free standing instrument panel near the metering run in the Wood Chip Boiler Building.

.4 Mount steam metering flow transmitters and pressure transmitter 5 ft. above floor.

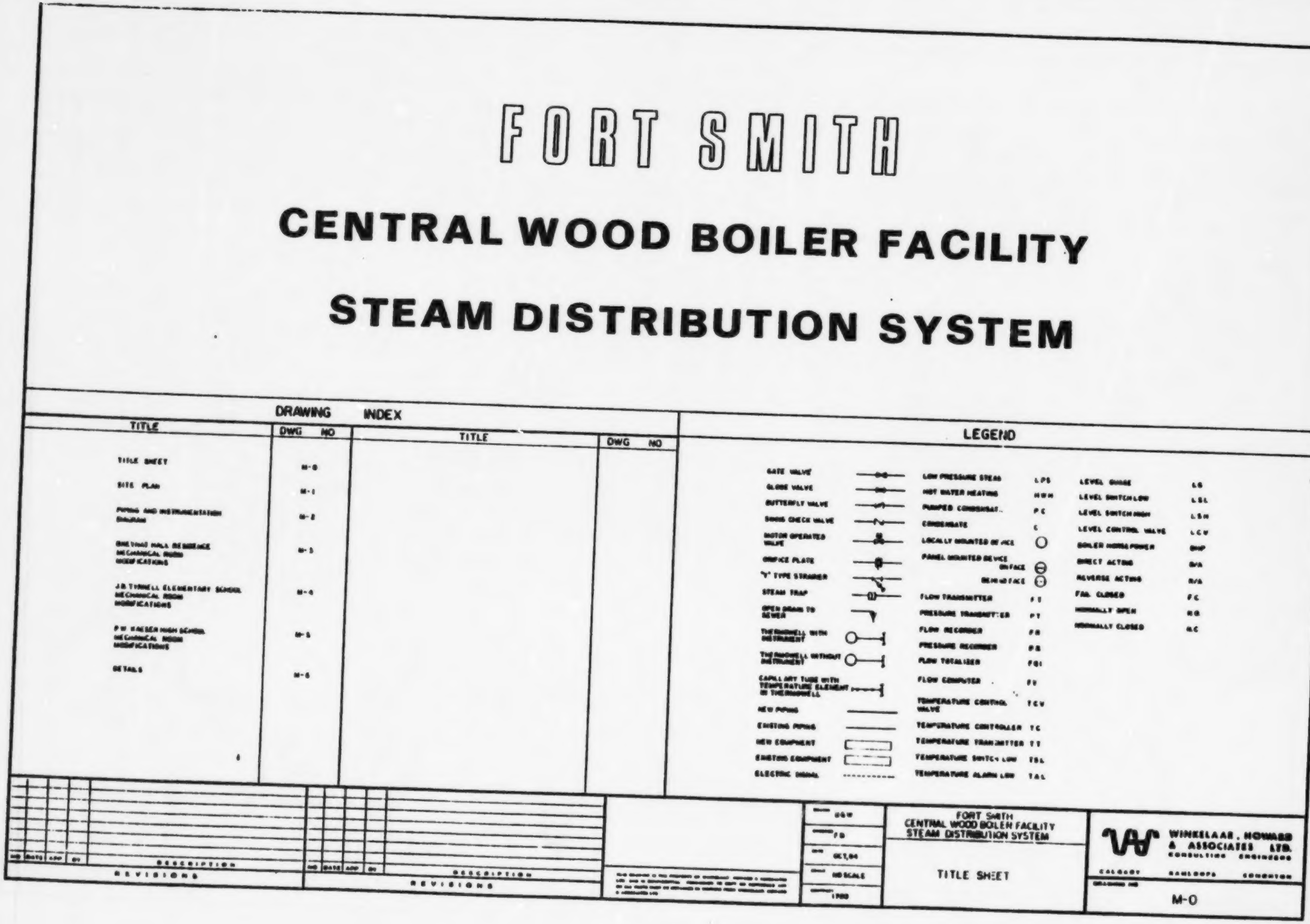
.5 Mount a common freeze alert alarm outside the Wood Chip Boiler Plant Building over main entrance door (alarm common for TSL-1, 2 & 3).

.6 Mount a freeze alert alarm outdoors, over the mechanical room entrance of each of the other buildings.

.7 Condensate receiver level switches to cycle condensate pumps. Install switches to operate pumps at levels shown on drawings. Provide hand-off-auto switch adjacent to each pump.

.8 Calibrate flow and pressure metering components, program computer.

APPENDIX C
MECHANICAL DRAWINGS OF THE STEAM DISTRIBUTION SYSTEM AND BUILDING TIE-INS



FORT SMITH

CENTRAL WOOD BOILER FACILITY

STEAM DISTRIBUTION SYSTEM

DRAWING INDEX

TITLE	DWG NO	TITLE	DWG NO
TITLE SHEET	M-0		
SITE PLAN	M-1		
PIPING AND INSTRUMENTATION DIAGRAM	M-2		
BREYNAT HALL RESIDENCE MECHANICAL ROOM MODIFICATIONS	M-3		
J.B. TYRRELL ELEMENTARY SCHOOL MECHANICAL ROOM MODIFICATIONS	M-4		
P.W. KAESER HIGH SCHOOL MECHANICAL ROOM MODIFICATIONS	M-5		
DETAILS	M-6		

LEGEND

GATE VALVE
GLOBE VALVE
BUTTERFLY VALVE
SWING CHECK VALVE
MOTOR OPERATED VALVE
ORIFICE PLATE
"Y" TYPE STRAINER
STEAM TRAP
OPEN DRAIN TO SEWER
THERMOWELL WITH INSTRUMENT
THERMOWELL WITHOUT INSTRUMENT
CAPILLARY TUBE WITH TEMPERATURE ELEMENT IN THERMOWELL
NEW PIPING
EXISTING PIPING
NEW COMPONENT
EXISTING COMPONENT
ELECTRIC SIGNAL

LOW PRESSURE STEAM	LPS
HOT WATER HEATING	HWH
PUMPED CONDENSAT..	PC
CONDENSATE	C
LOCALLY MOUNTED DEVICE	○
PANEL MOUNTED DEVICE ON FACE	⊖
BEHIND FACE	⊝
FLOW TRANSMITTER	FT
PRESSURE TRANSMITTER	PT
FLOW RECORDER	FR
PRESSURE RECORDER	PR
FLOW TOTALIZER	FQI
FLOW COMPUTER	FY
TEMPERATURE CONTROL VALVE	TCV
TEMPERATURE CONTROLLER	TC
TEMPERATURE TRANSMITTER	TT
TEMPERATURE SWITCH LOW	TSL
TEMPERATURE ALARM LOW	TAL

LEVEL GAUGE	LG
LEVEL SWITCH LOW	LSL
LEVEL SWITCH HIGH	LSH
LEVEL CONTROL VALVE	LCV
BOILER HORSEPOWER	BHP
DIRECT ACTING	D/A
REVERSE ACTING	R/A
FAIL CLOSED	FC
NORMALLY OPEN	NO
NORMALLY CLOSED	NC

NO	DATE	APP	BY	DESCRIPTION

REVISIONS

NO	DATE	APP	BY	DESCRIPTION

REVISIONS

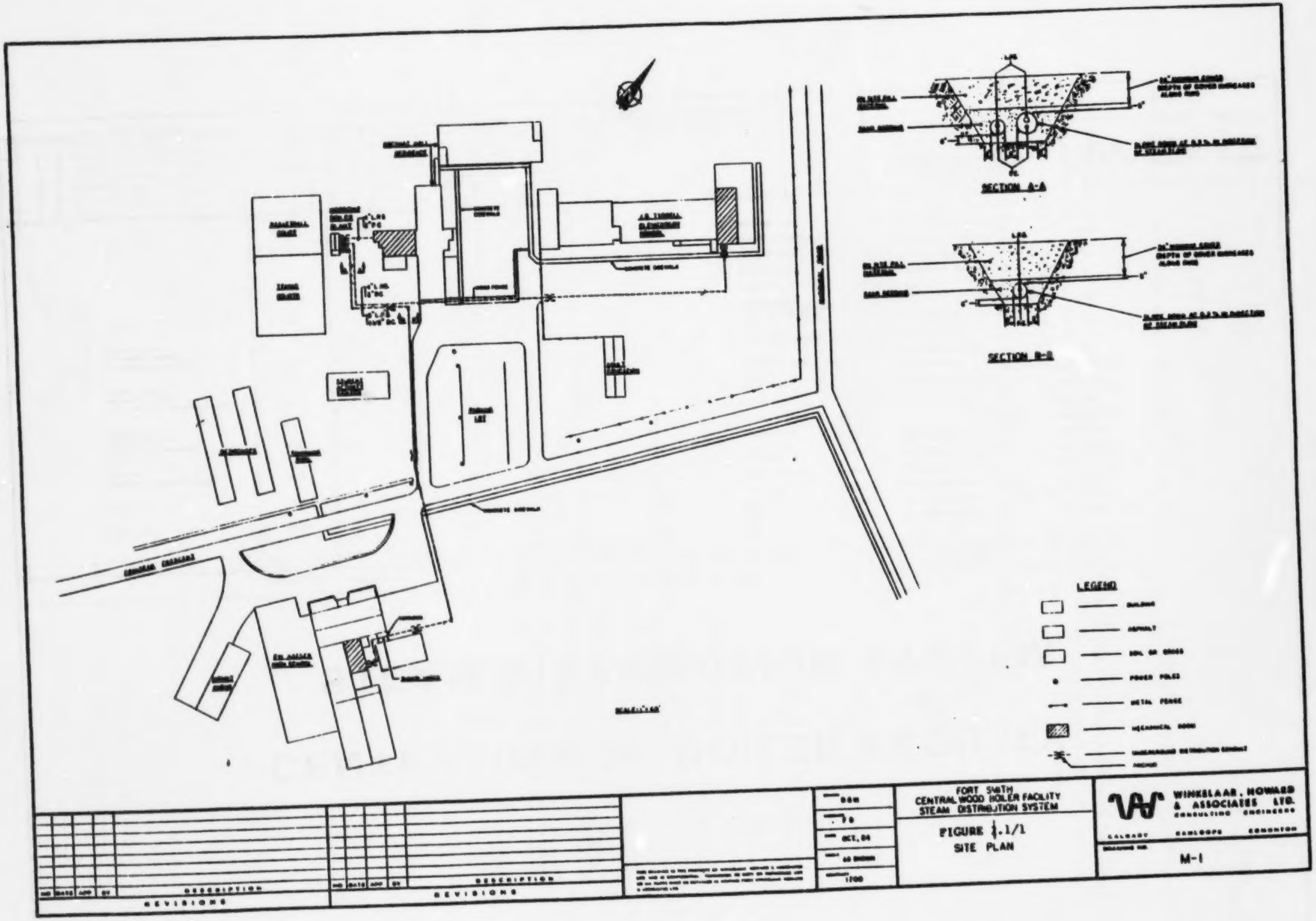
DGW
FD
OCT,84
NO SCALE
1980

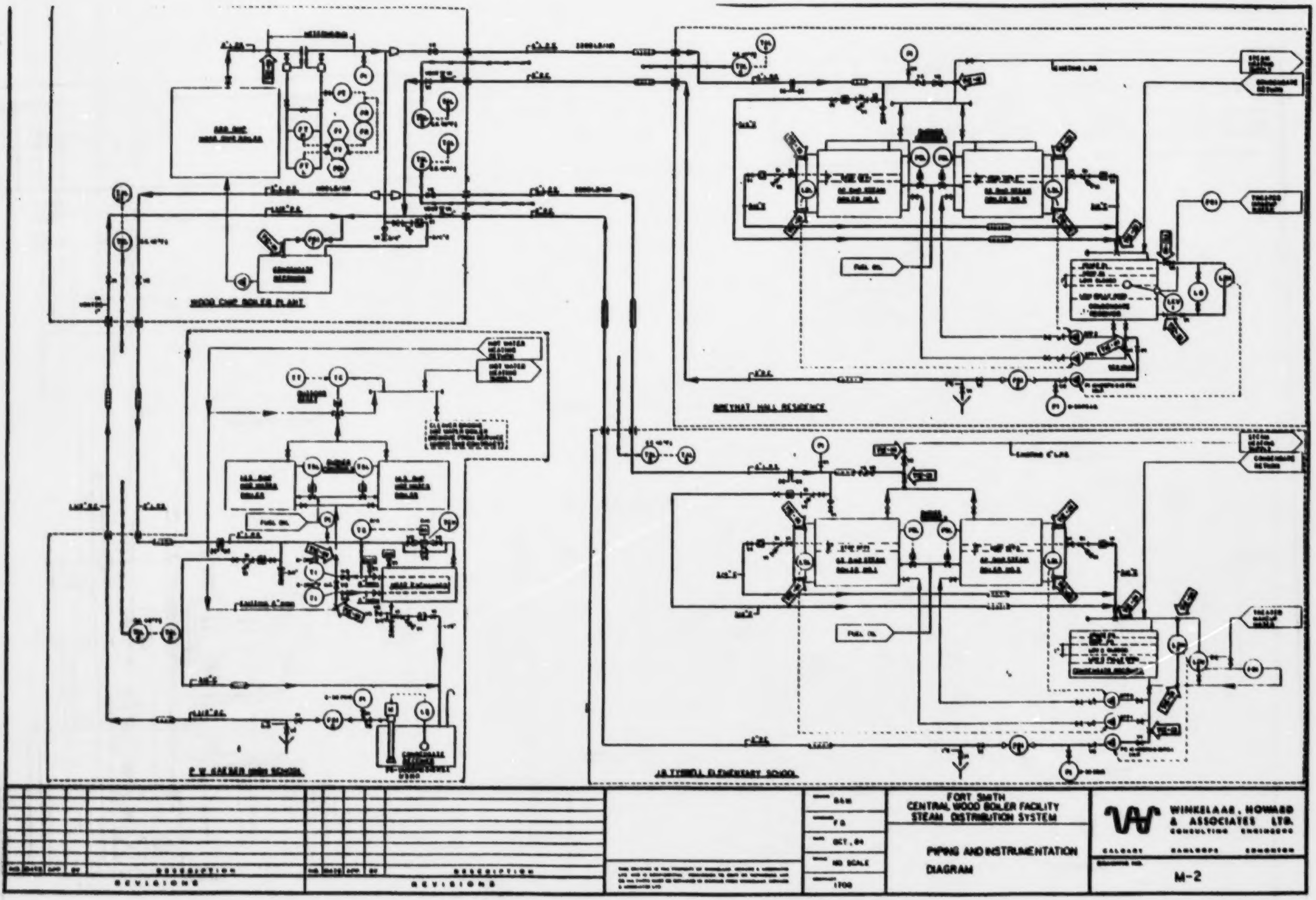
FORT SMITH
CENTRAL WOOD BOILER FACILITY
STEAM DISTRIBUTION SYSTEM

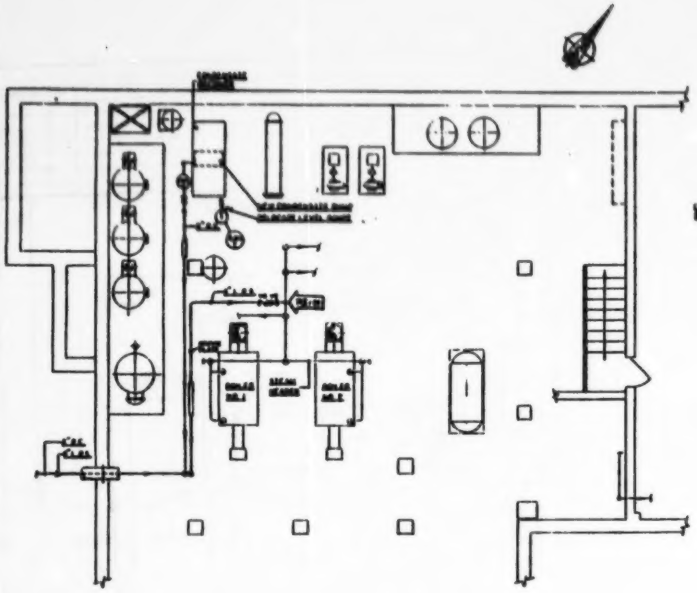
TITLE SHEET

WINKELAAR, HOWARD & ASSOCIATES LTD.
CONSULTING ENGINEERS
CALGARY KAMLOOPS EDMONTON

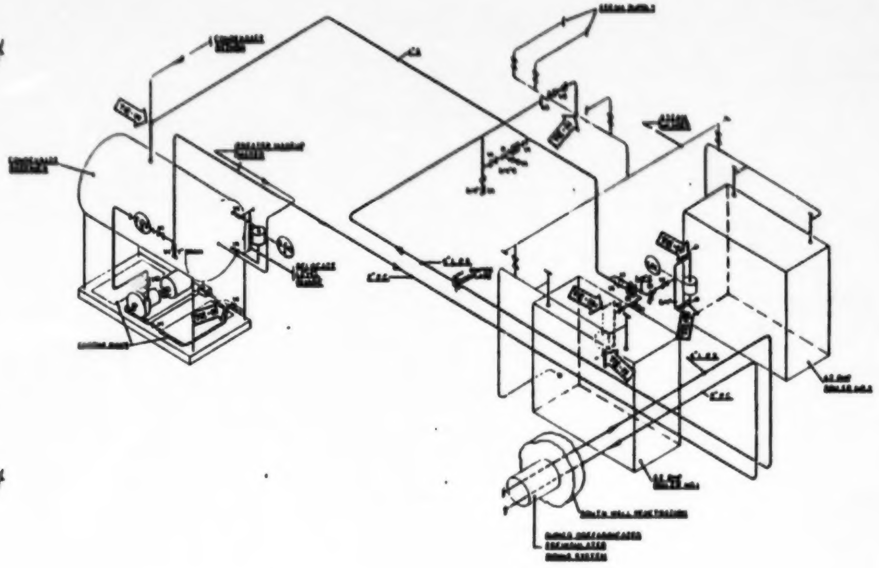
M-0


SECTION A-A
SECTION B-B
LEGEND
BUILDING
ASPHALT
SOIL OR GRASS
POWER POLES
METAL FENCE
MECHANICAL ROOM
UNDERGROUND DISTRIBUTION CONDUIT
ANCHOR
FORT SMITH
CENTRAL WOOD BOILER FACILITY
STEAM DISTRIBUTION SYSTEM
FIGURE 1.1/1
SITE PLAN
WINKELAAR, HOWARD & ASSOCIATES LTD.
CONSULTING ENGINEERS
CALGARY
KAMLOOPS
EDMONTON
M-1
OCT. 84
AS SHOWN
1700
DESCRIPTION
REVISIONS


WOOD CHIP BOILER PLANT
CONDENSATE RECEIVER
HOT WATER HEATING RETURN
HOT WATER HEATING SUPPLY
FUEL OIL
HEAT EXCHANGER
P.W. KAESER HIGH SCHOOL
BREYNAT HALL RESIDENCE
STEAM HEATING SUPPLY
CONDENSATE RETURN
J.B. TYRRELL ELEMENTARY SCHOOL
DESCRIPTION
REVISIONS
D.A.M.
F.D.
OCT, 84
NO SCALE
1700
FORT SMITH
CENTRAL WOOD BOILER FACILITY
STEAM DISTRIBUTION SYSTEM
PIPING AND INSTRUMENTATION DIAGRAM
WINKELAAR, HOWARD & ASSOCIATES LTD.
CONSULTING ENGINEERS
CALGARY
KAMLOOPS
EDMONTON
M-2


C.R.C.
C.L.R.S.
BOILER NO.1
STEAM HEADER
BOILER NO.2

MECHANICAL ROOM
SCALE : 1/8" = 1'-0"



NO	DATE	APP	BY	DESCRIPTION
				REVISIONS

NO	DATE	APP	BY	DESCRIPTION
				REVISIONS

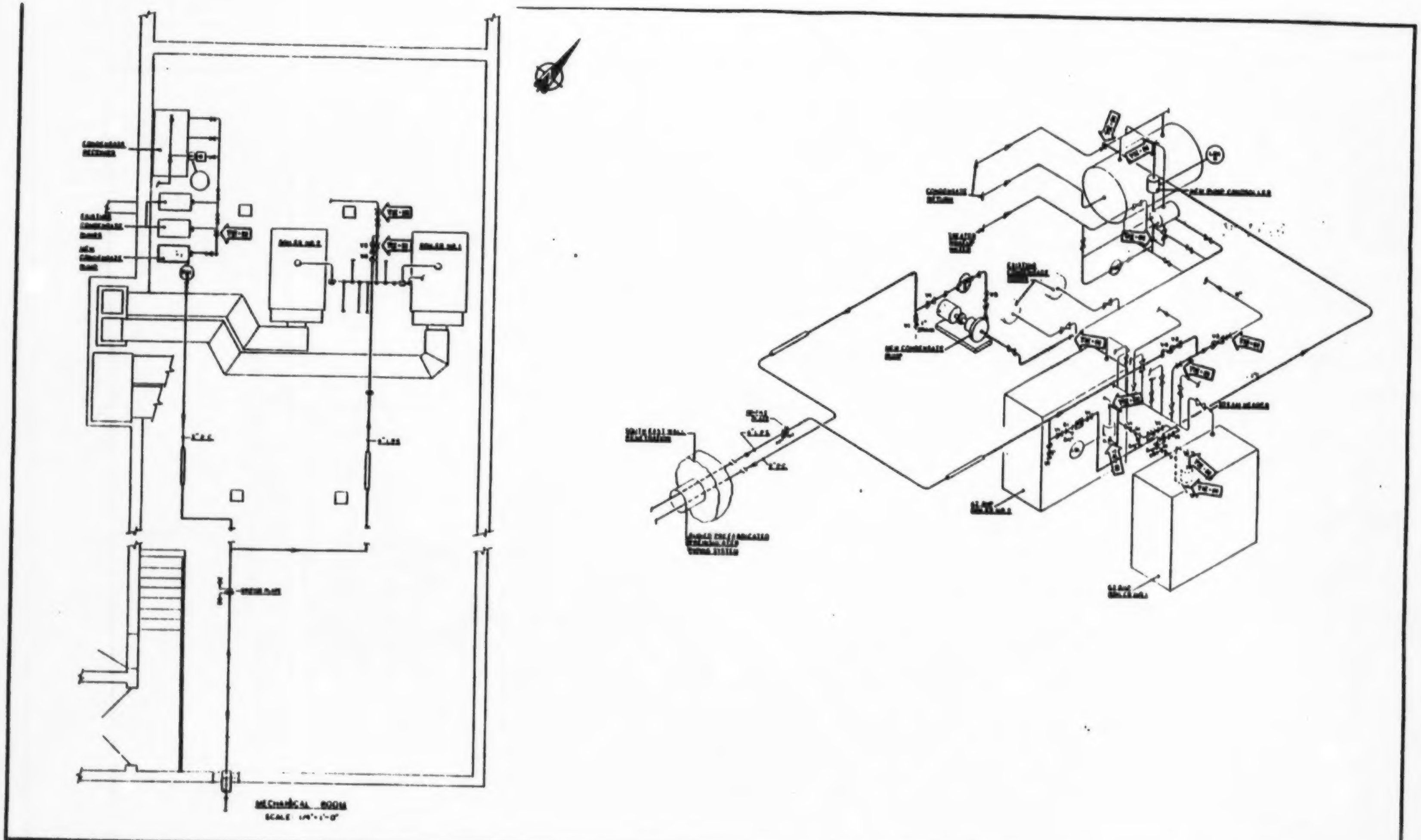
DGH
FB
OCT, 84
AS SHOWN
1700

FORT SMITH
CENTRAL WOOD BOILER FACILITY
STEAM DISTRIBUTION SYSTEM

BREYNAT HALL RESIDENCE
MECHANICAL ROOM
MODIFICATIONS

WINKELAAR, HOWARD
& ASSOCIATES LTD.
CONSULTING ENGINEERS
CALGARY KAMLOOPS EDMONTON

M-3


CONDENSATE RECEIVER
EXISTING CONDENSATE PUMPS
NEW CONDENSATE PUMP
BOILER NO. 2
BOILER NO. 1
CONDENSATE RETURN
NEW PUMP CONTROLLER
EXISTING CONDENSATE
NEW CONDENSATE PUMP
STEAM HEADER
SOUTH EAST WALL

MECHANICAL ROOM
SCALE 1/4" = 1'-0"

NO	DATE	APP	BY	DESCRIPTION
				REVISIONS

NO	DATE	APP	BY	DESCRIPTION
				REVISIONS

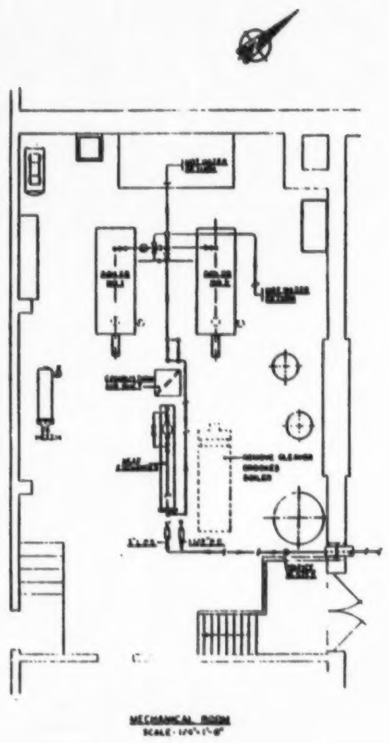
D.S.H.
F.B.
OCT., 84
AS SHOWN
1700

FORT SMITH
CENTRAL WOOD BOILER FACILITY
STEAM DISTRIBUTION SYSTEM

J.B. TYRRELL ELEMENTARY SCHOOL
MECHANICAL ROOM
MODIFICATIONS

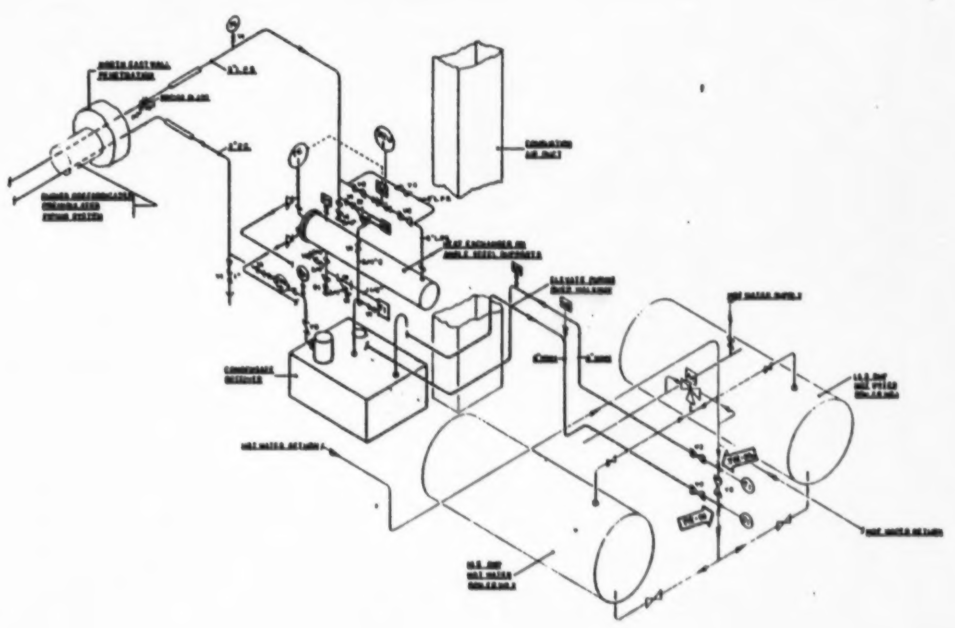
WINKELAAR, HOWARD
& ASSOCIATES LTD.
CONSULTING ENGINEERS
CALGARY KAMLOOPS EDMONTON

M-4



MECHANICAL ROOM

SCALE: 1/8" = 1'-0"


NORTH EAST WALL PENETRATION
COMBUSTION AIR DUCT
HEAT EXCHANGER ON ANGLE STEEL SUPPORTS
ELEVATE PIPING OVER WALKWAY
CONDENSATE RECEIVER
HOT WATER SUPPLY
HOT WATER RETURN

NO	DATE	APP	BY	DESCRIPTION	NO	DATE	APP	BY	DESCRIPTION
				REVISIONS					REVISIONS

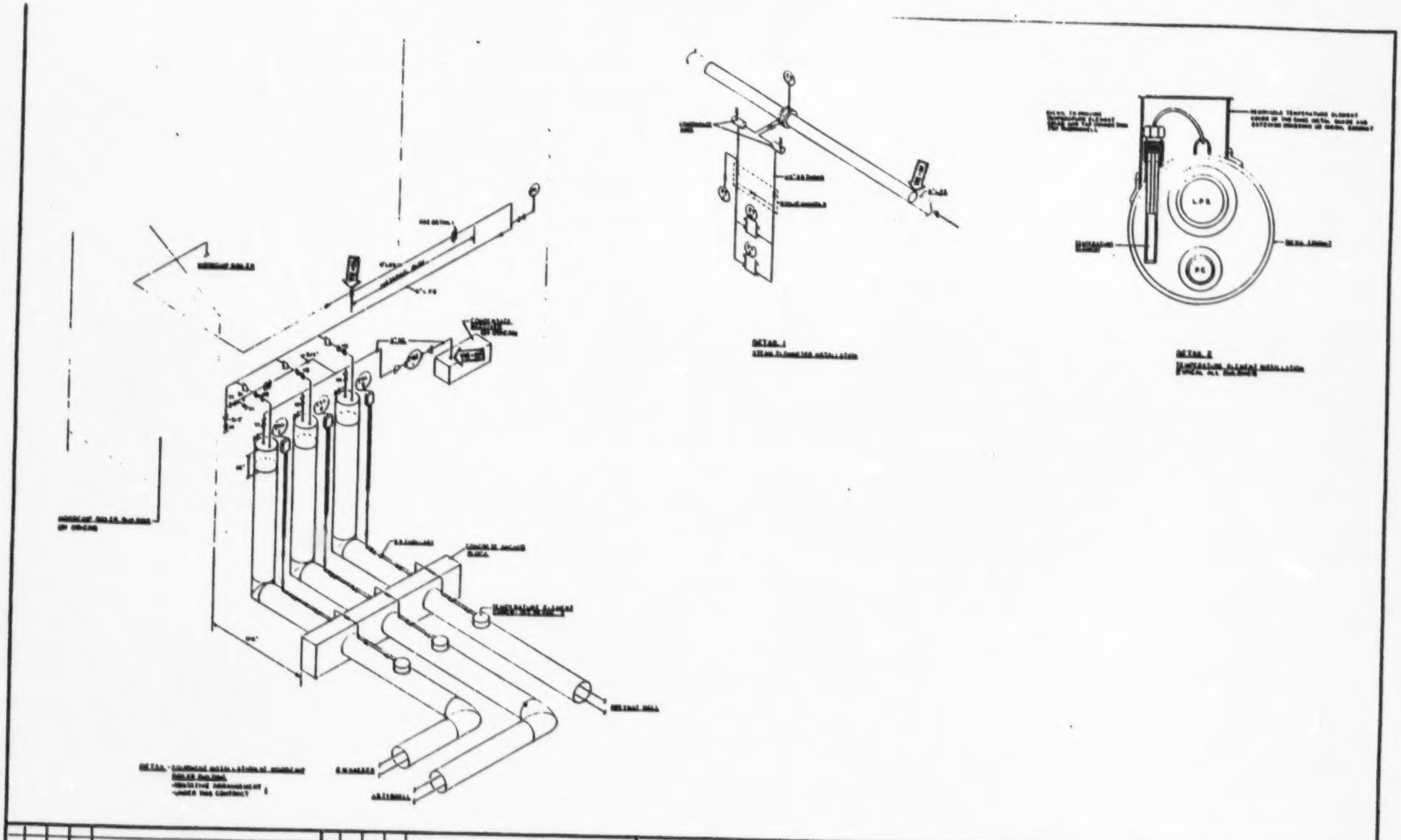
DRAWN DGN
CHECKED F.G.
DATE OCT. 84
SCALE AS SHOWN
CONTRACT 1700

FORT SMITH
CENTRAL WOOD BOILER FACILITY
STEAM DISTRIBUTION SYSTEM

P.W. KAESER HIGH SCHOOL
MECHANICAL ROOM
MODIFICATIONS

WINKELAAR, HOWARD & ASSOCIATES LTD.
CONSULTING ENGINEERS
CALGARY KAMLOOPS EDMONTON

DRAWING NO
M-5



NO	DATE	APP	BY	DESCRIPTION	NO	DATE	APP	BY	DESCRIPTION
				REVISIONS					REVISIONS

DRAWN B&H
CHECKED FB
DATE OCT,84
SCALE NO SCALE
CONTRACT 1700

FORT SMITH
CENTRAL WOOD BOILER FACILITY
STEAM DISTRIBUTION SYSTEM

DETAILS

WINKELAAR, HOWARD
& ASSOCIATES LTD.
CONSULTING ENGINEERS
CALGARY KAMLOOPS EDMONTON

DRAWING NO
M-6